Cornell University
Laboratory for Elementary-Particle Physics

CesrTA R&D Program

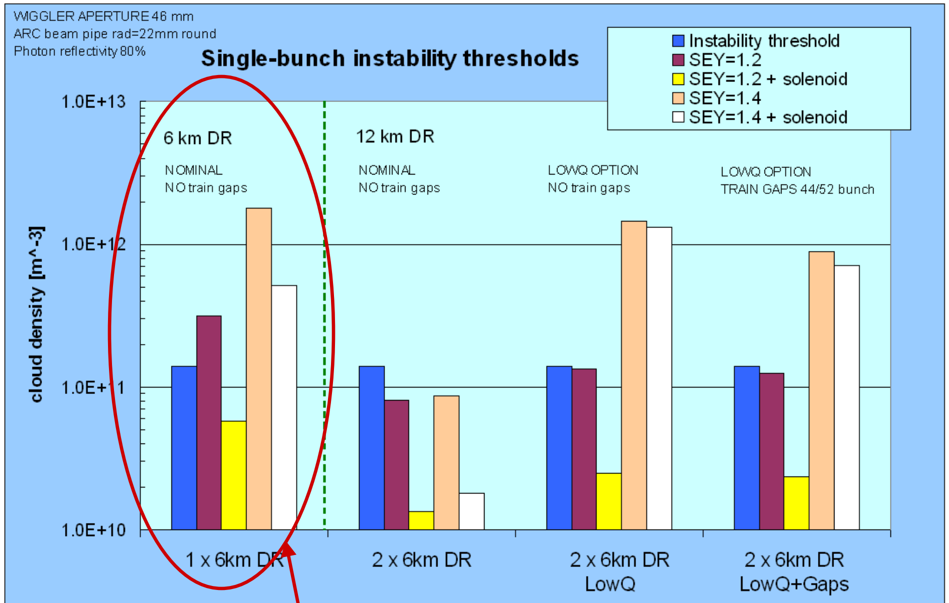
Mark Palmer for the CesrTA Collaboration
May 13, 2010

ILC PAC Meeting - Valencia

Outline

- Project Overview
  – Motivation
  – Project Goals
  – Reconfiguration
  – Status
- R&D Effort (Selected Items)
  – Low Emittance Correction and Tuning
  – EC Studies
    - Build-Up and Mitigation
    - EC Beam Dynamics
    - Simulation Program
- Conclusion

Motivation for CESRTA



- ILCDR06 Evaluation
  - M. Pivi, K. Ohmi, *etal.*
  - Single ~6km positron DR
    - Nominal ~2625 bunches with 6ns bunch spacing and N_b=2 10^{10}
    - Requires SEY values of vacuum chamber surfaces with $\delta_{max} \leq 1.2$ (assuming solenoid windings in drift regions) in order to operate below EC instability thresholds
    - Dipole and wiggler regions of greatest concern for EC build-up

- In 2007, the ILC R&D Board's S3 Task Force identified a set of critical research tasks for the ILC DR, including:
  - Characterize EC build-up
  - Develop EC suppression techniques
  - Develop modelling tools for EC instabilities
  - Determine EC instability thresholds
- CesrTA program targets:
  - Measurements with positron beams at ultra low emittance to validate projections to the ILC DR operating regime
  - Validation of EC mitigation methods that will allow safe operation of the baseline DR design and the possibility of performance improvements and/or cost reductions

R&D Goals

- Studies of Electron Cloud Growth and Mitigation
  - Study EC growth and methods to mitigate it, particularly in the wigglers and dipoles which are of greatest concern in the ILC DR design.
  - Use these studies to benchmark and expand existing simulation codes and to validate our projections for the ILC DR design.
- Low Emittance Operations
  - Support EC studies with beam emittances approaching those specified for the ILC DR (CesrTA vertical emittance target: ε_v<20 pm-rad).
  - Implement beam instrumentation needed to achieve and characterize ultra low emittance beams
    - x-Ray Beam Size Monitor targeting bunch-by-bunch (single pass) readout
    - Beam Position Monitor upgrade
  - Develop tuning tools to achieve and maintain ultra low emittance operation in coordination with the ILC DR LET effort
- Studies of EC Induced Instability Thresholds and Emittance Dilution
  - Measure instability thresholds and emittance growth due to the EC in a low emittance regime approaching that of the ILC DR.
  - Validate EC simulations in the low emittance parameter regime.
  - Confirm the projected impact of the EC on ILC DR performance.
- Inputs for the ILC DR Technical Design
  - Support an experimental program to provide key results on the 2010 timescale

Project Elements

- 4 Major Thrusts:
  - Ring Reconfiguration: Vacuum/Magnets/Controls Modifications
  - Low Emittance R&D Support
    - Instrumentation: BPM system and high resolution x-ray Beam Size Monitors
    - Survey and Alignment Upgrade
  - Electron Cloud R&D Support
    - Local EC Measurement Capability: RFAs, TE Wave Measurements, Shielded Pickups
    - Feedback System upgrade for 4ns bunch trains
    - Photon stop for wiggler tests over a range of energies (1.8 to 5 GeV)
    - Local SEY measurement capability
  - Experimental Program
    - Provide sufficient running time to commission hardware, carry out planned experiments, and explore surprises
      ➪ ~240 running days over a 2+ year period
    - Early results to feed into final stages of program
- Schedule coordinated with Cornell High Energy Synchrotron Source (CHESS) operations

Large parameter range – see next slide

CESR Reconfiguration: CesrTA Parameters

Lattice Parameters

Ultra low emittance baseline lattice

Energy [GeV]	2.085	5.0	5.0
No. Wigglers	12	0	6
Wiggler Field [T]	1.9	—	1.9
Q_x	14.57		
Q_y	9.62		
Q_z	0.075	0.043	0.043
V_{RF} [MV]	8.1	8	8
ε_x [nm-rad]	2.5	60	40
$\tau_{x,y}$ [ms]	57	30	20
α_p	$6.76\ 10^{-3}$	$6.23\ 10^{-3}$	$6.23\ 10^{-3}$
σ_l [mm]	9	9.4	15.6
σ_E/E [%]	0.81	0.58	0.93
t_b [ns]	≥4, steps of 2		

Range of optics implemented

Beam dynamics studies

Control photon flux in EC experimental regions

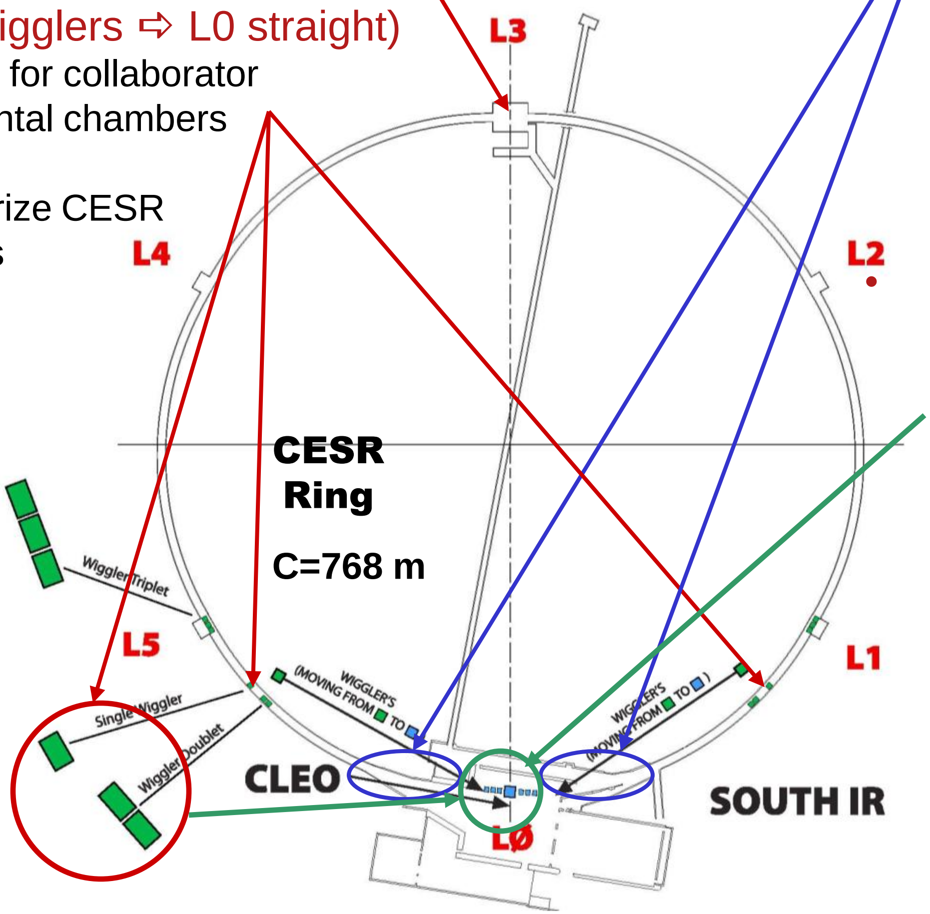
E[GeV]	Wigglers (1.9T/PM)	ε_x[nm]
1.8*	12/0	2.3
2.085	12/0	2.5
2.3	12/0	3.3
3.0	6/0	10
4.0	6 /0	23
4.0	0 /0	42
5.0	6/0	40
5.0	0/0	60
5.0	0/2	90

IBS Studies (rows 1.8*, 2.085, 2.3)

* Orbit/phase/coupling correction and injection but no ramp and recovery. In all other optics there has been at least one ramp and iteration on injection tuning and phase/coupling correction

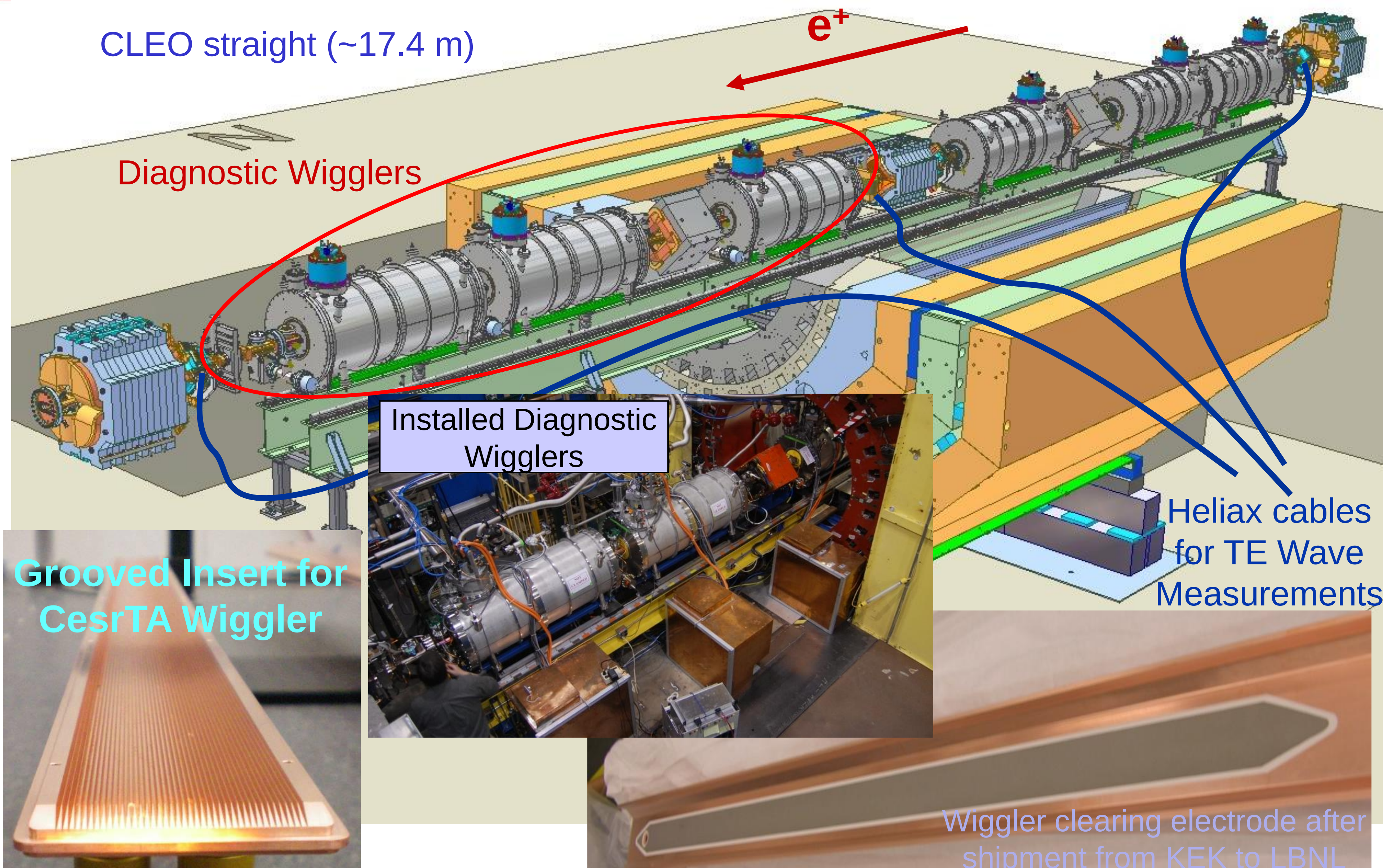
CESR Reconfiguration

- L3 EC experimental region
  - PEP-II EC Hardware: Chicane, upgraded SEY station
  - Drift and Quadrupole diagnostic chambers
- New EC experimental regions in arcs (wigglers ⇨ L0 straight)
  - Locations for collaborator experimental chambers
  - Characterize CESR chambers

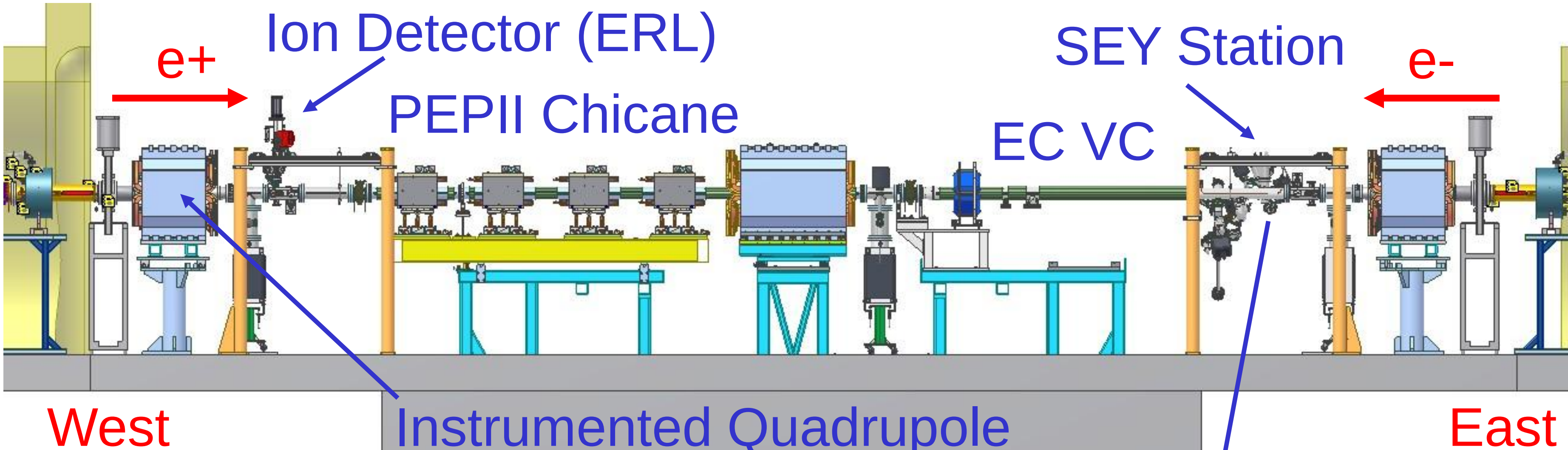


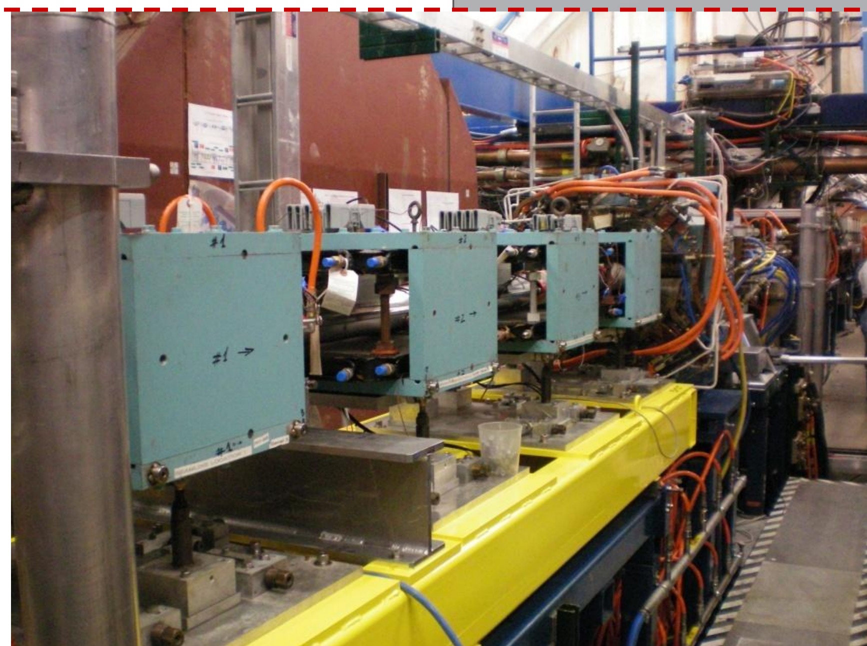
- CHESS C-line & D-line Upgrades
  - Windowless (all vacuum) x-ray line upgrade
  - Dedicated x-ray optics box at start of each line
  - CesrTA xBSM detectors share space in CHESS experimental hutches
- L0 region reconfigured as a wiggler straight
  - CLEO detector sub-systems removed
  - 6 wigglers moved from CESR arcs to zero dispersion straight
  - Region instrumented with EC diagnostics and mitigation
  - Wiggler chambers with retarding field analyzers and various EC mitigation methods (fabricated at LBNL in CU/SLAC/KEK/LBNL collaboration)

CESR Reconfiguration; L0 Modifications



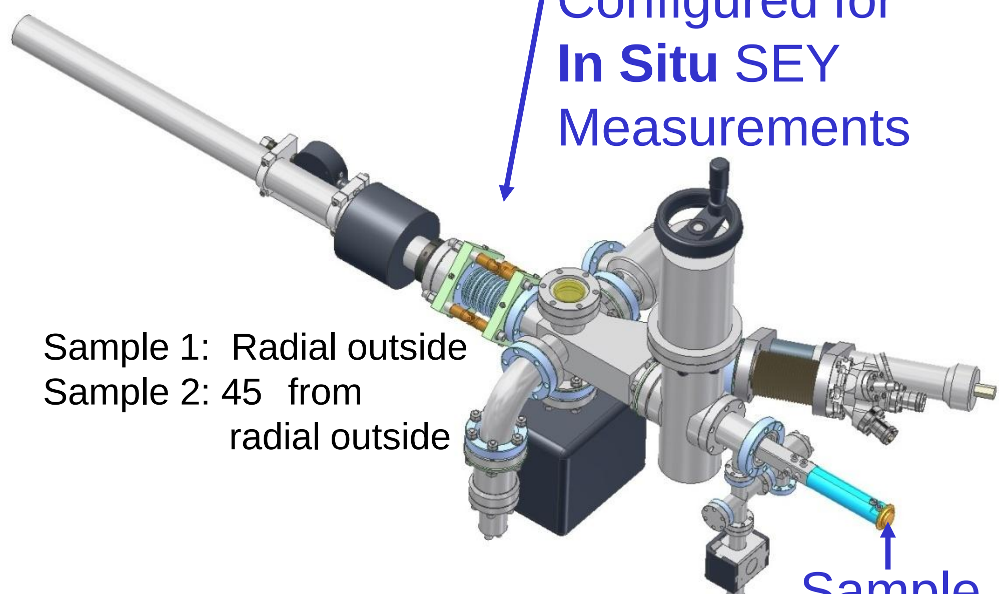
CESR Reconfiguration: L3 Experimental Region



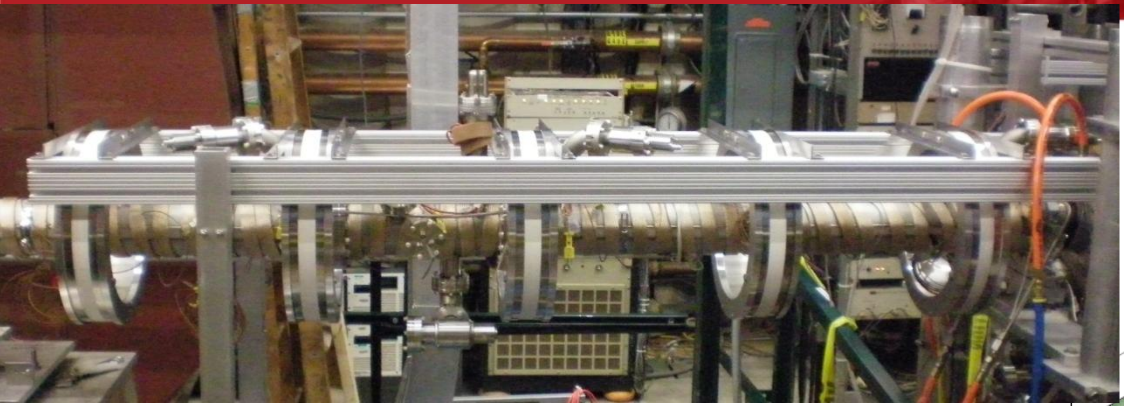


Configured for **In Situ** SEY Measurements

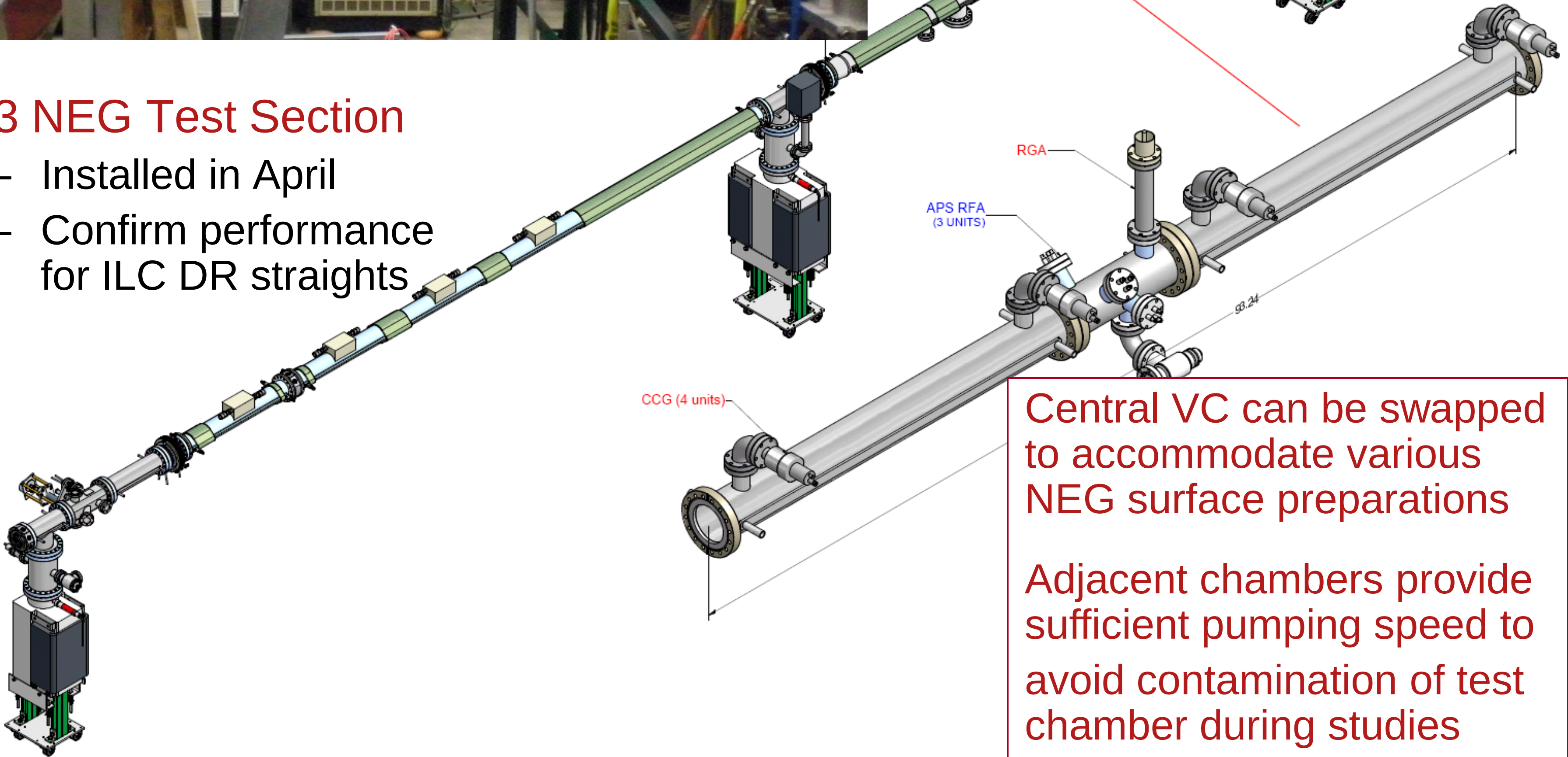
Sample 1: Radial outside
Sample 2: 45 from
radial outside



CESR Reconfiguration: L3 Experimental Region



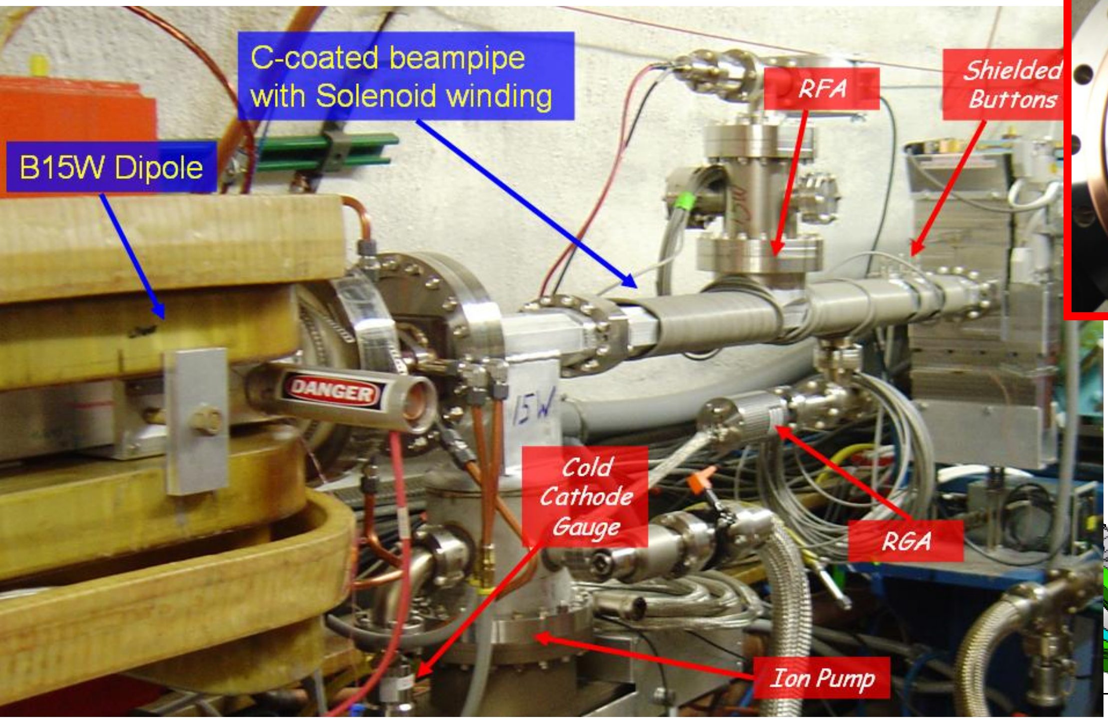
- L3 NEG Test Section
  - Installed in April
  - Confirm performance for ILC DR straights

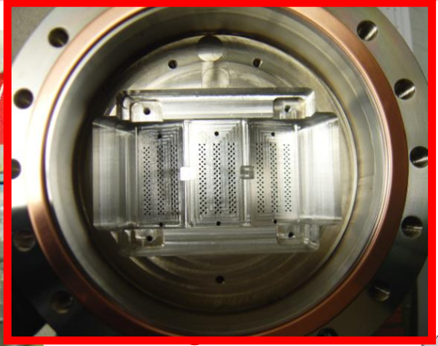


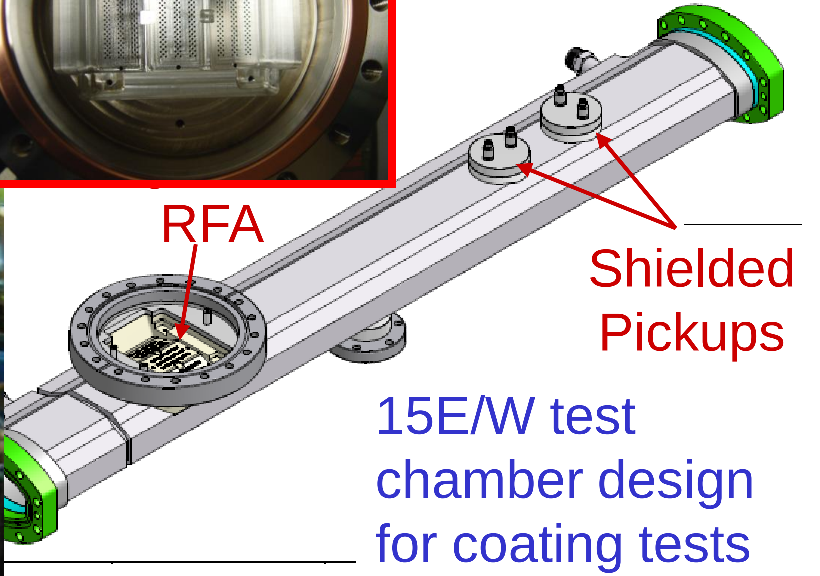
Central VC can be swapped to accommodate various NEG surface preparations

Adjacent chambers provide sufficient pumping speed to avoid contamination of test chamber during studies

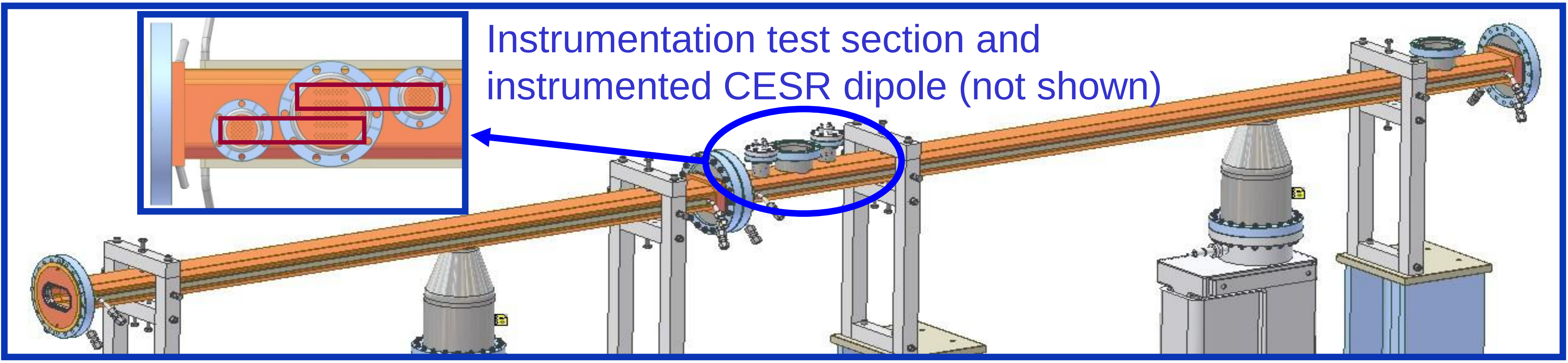
CESR Reconfiguration: CESR Arcs







15E/W test chamber design for coating tests



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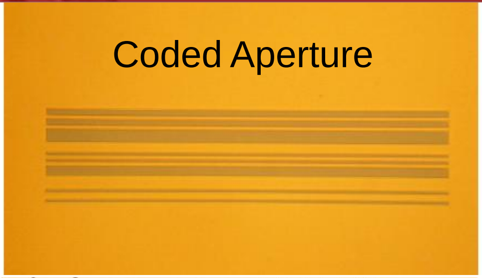
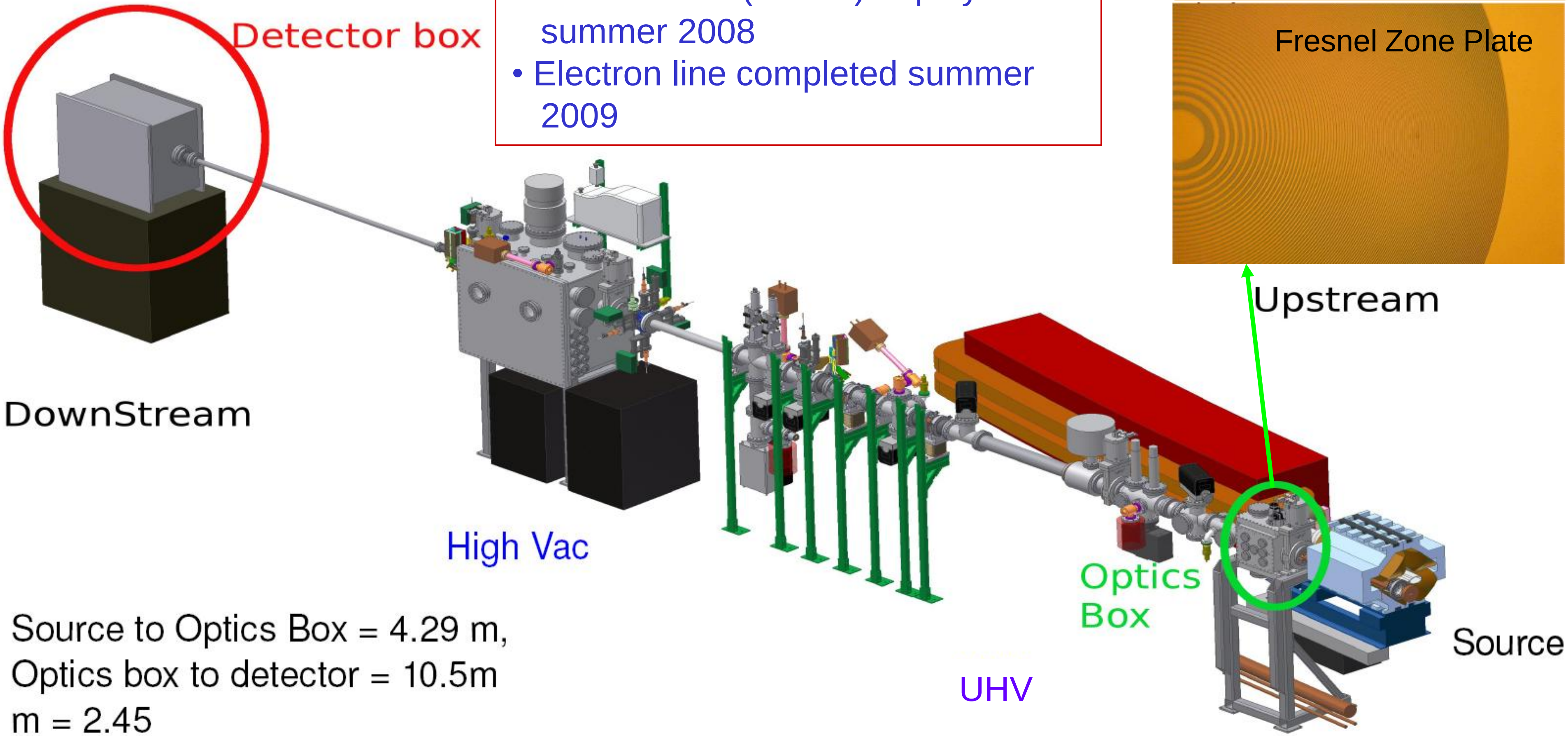
CESR Reconfiguration: X-Ray Lines

Detector: InGaAs Array
Single-pass readout
Few micron resolution

New all-vacuum optics lines installed in collaboration with CHESS:

- Positron line (shown) deployed summer 2008
- Electron line completed summer 2009

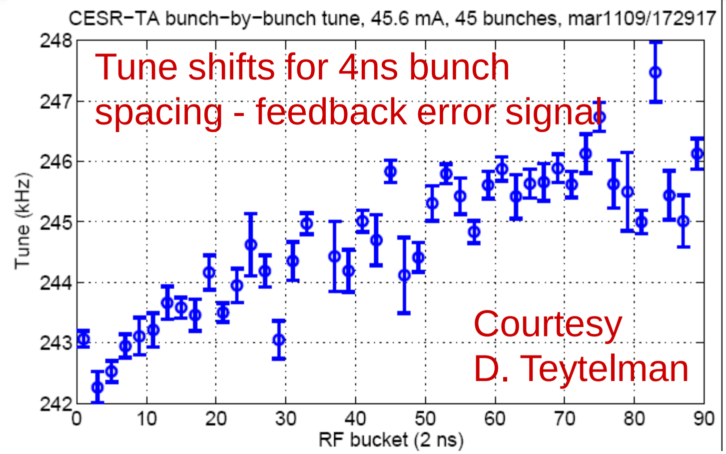




Source to Optics Box = 4.29 m,
Optics box to detector = 10.5m
m = 2.45

Status and Ongoing Effort

- **Ring Reconfiguration** — Complete
  - Damping ring layout
  - 4 dedicated EC experimental regions
  - Upgraded vacuum/EC instrumentation
- **Beam Instrumentation**
  - xBSM positron and electron lines operational
    - Continued optics and detector development
  - Digital BPM system operational
    - Continued effort on data acquisition and experimental data modes
  - vBSM
    - Significant progress has been made on vertical polarization measurements which can provide a useful cross-check with the xBSM in the ultra low emittance regime
    - New optics line for transverse and longitudinal measurements in L3 have are now in use
  - Feedback system upgrade for 4ns bunch spacing is operational



- **EC Diagnostics and Mitigation**
  - ~30 RFAs presently deployed
  - TE wave measurement capability in each experimental region
  - Time-resolved shielded pickup detectors in 3 experimental locations (2 with transverse information)
  - Mitigation tests are ongoing
- **Low Emittance Tuning and Beam Dynamics Studies**
  - Approaching target vertical emittance of 20pm (see following slides)
  - Continuing effort to take advantage of new instrumentation
  - Continuing to work towards providing low emittance conditions for beam dynamics studies

R&D Effort

- Will Highlight A Few Items
- Low Emittance Correction and Tuning
- EC Studies
  - Build-Up and Mitigation
  - EC Beam Dynamics
  - Simulation Program

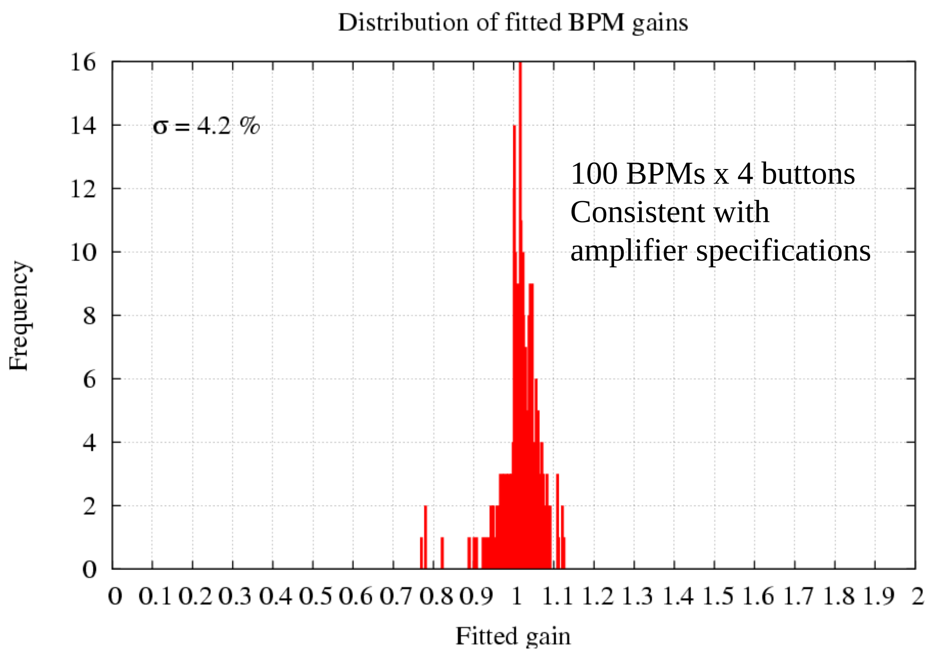
Collaboration

- The productivity of the program is determined by the range of collaboration involved:
  - Vacuum chambers with EC mitigation:
    - CERN, KEK, LBNL, SLAC
  - Low Emittance Tuning and Instrumentation
    - CalPoly, CERN, Cockcroft, KEK, SLAC
  - EC Instrumentation
    - FNAL,KEK, LBNL, SLAC
  - SEY Station
    - Carleton, FNAL, SLAC
  - Simulation
    - CERN, KEK, INFN-Frascati, LBNL, Postech, Purdue, SLAC
  - Technical Systems Checks
    - BNL, CERN, KEK

Low Emittance Tuning

- LET Procedure

1. Collect turn by turn data with resonant excitation of horizontal and vertical motion
2. Fit BPM gains
3. Measure and correct
   - Orbit, with steerings
   - Betatron phase and coupling, with quads and skew quads
4. Measure dispersion by resonant excitation of synch tune
5. Fit simultaneously – coupling,vertical dispersion and orbit using vertical steerings and skew quads and load corrections



December Run – Measured ε_y =31pm with xBSM.

D. Rubin

Low Emittance Working Point

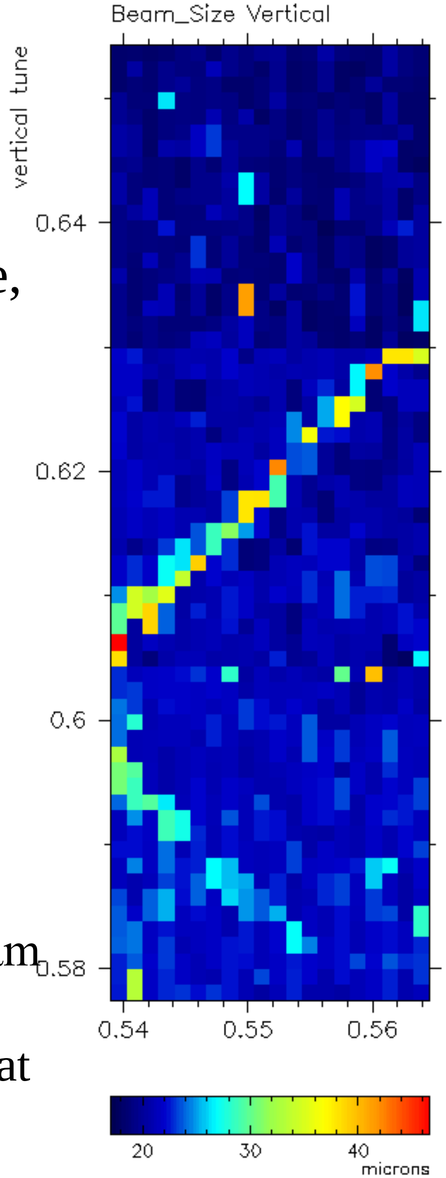
Vertical beam size, measured with x-ray beam size monitor (pinhole optic) vs tune

Q_s=0.066

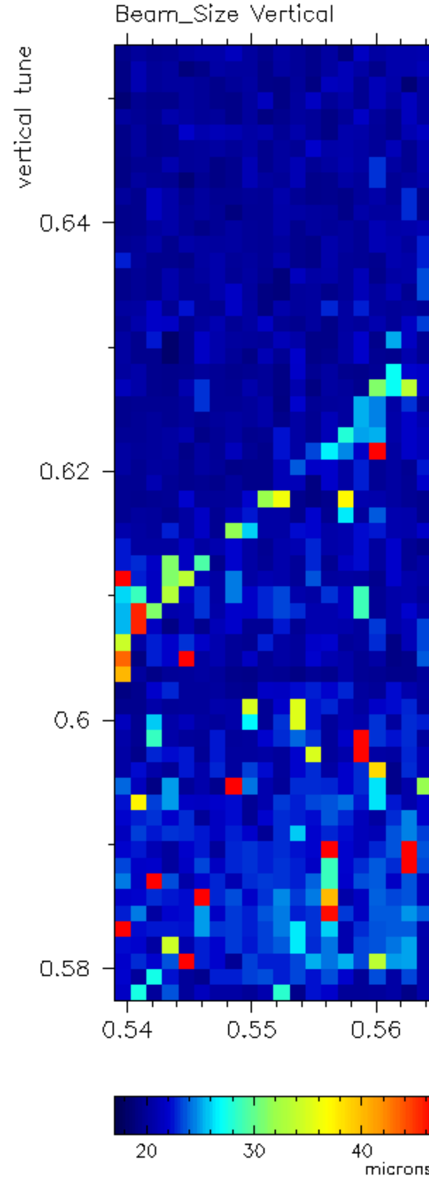
β_v=17m,
(20 μm ⇨ 23pm)

Pinhole optics –
limited to ≥ ~ 20μm

Significant regions at limit



2 family sextupole distribution



Sextupoles optimized to minimize resonance driving terms

Status of EC Studies

Simulations:

- Code Benchmarking (CLOUDLAND, ECLOUD, POSINST)
- Modeling for RFA and TE Wave measurements
  - RFA Model: Local data ⇨ EC parameters of surface
  - TE wave measurements: probe regions not accessible to RFA measurements (eg, through length of wiggler)
- Tune shift calculations
  - Characterize the integrated SEY contributions around the ring
- Instability estimates and emittance growth
  - Detailed comparisons with data in the ultra low emittance regime
  - Validate projections for the DR

Measurements:

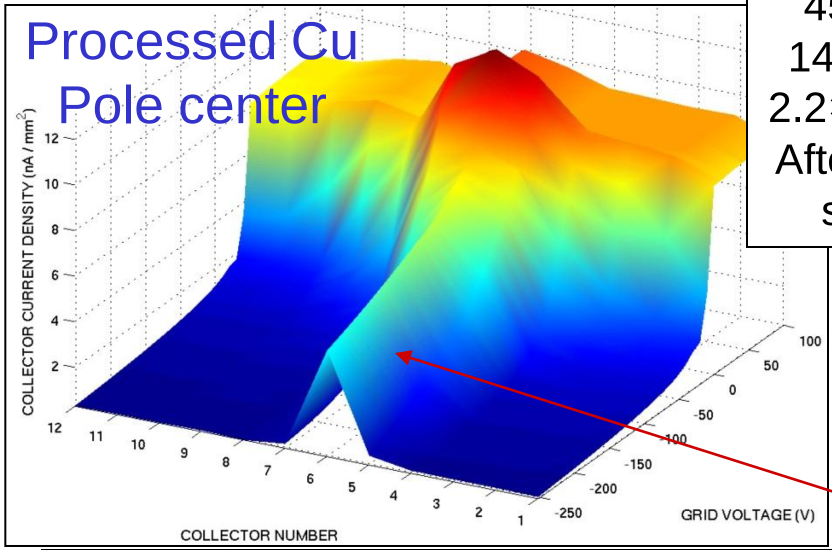
- RFA and TE Wave studies to characterize local EC growth
  - Wigglers, dipoles, drifts, quadrupoles
  - 2 GeV to 5 GeV studies
  - Variety of bunch train lengths, spacing and intensities
  - Studies with electron and positron beams
- Time-resolved measurements
  - Important cross-checks of EC models
- Mitigation Comparisons
  - Drift, Quadrupole, Dipole and Wiggler
  - See table on next slide
- Tune shift measurements and systematic checks
- Instability and emittance growth (w/xBSM) measurements are underway

Surface Characterization & Mitigation Tests

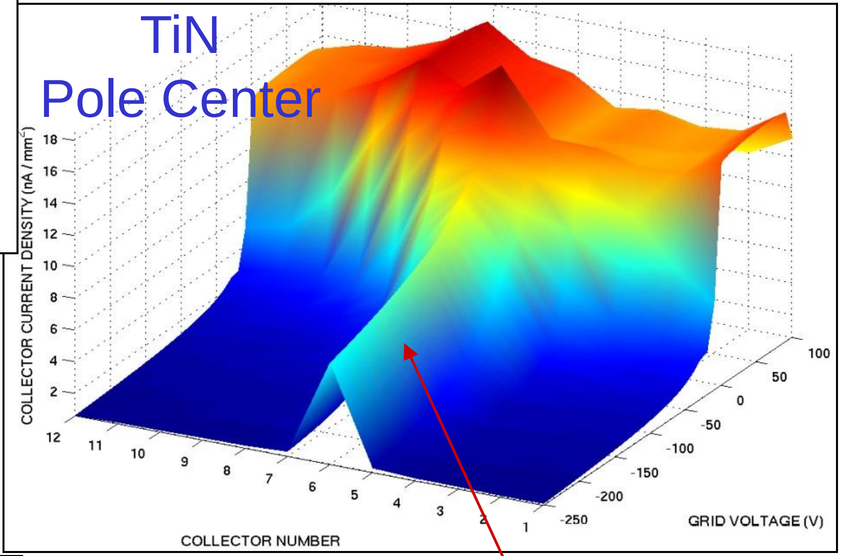
	Drift	Quad	Dipole	Wiggler	VC Fab
Al	✓	✓	✓		CU, SLAC
Cu	✓			✓	CU, KEK, LBNL, SLAC
TiN on Al	✓	✓	✓		CU, SLAC
TiN on Cu	✓			✓	CU, KEK, LBNL, SLAC
Amorphous C on Al	✓				CERN, CU
NEG on SS	✓				CU
Fins w/TiN on Al	✓				SLAC
Triangular Grooves on Cu				✓	CU, KEK, LBNL, SLAC
Triangular Grooves w/TiN on Al			✓		SLAC
Triangular Grooves w/TiN on Cu				✓ (planned)	CU, KEK, LBNL, SLAC
Clearing Electrode				✓	CU, KEK, LBNL, SLAC

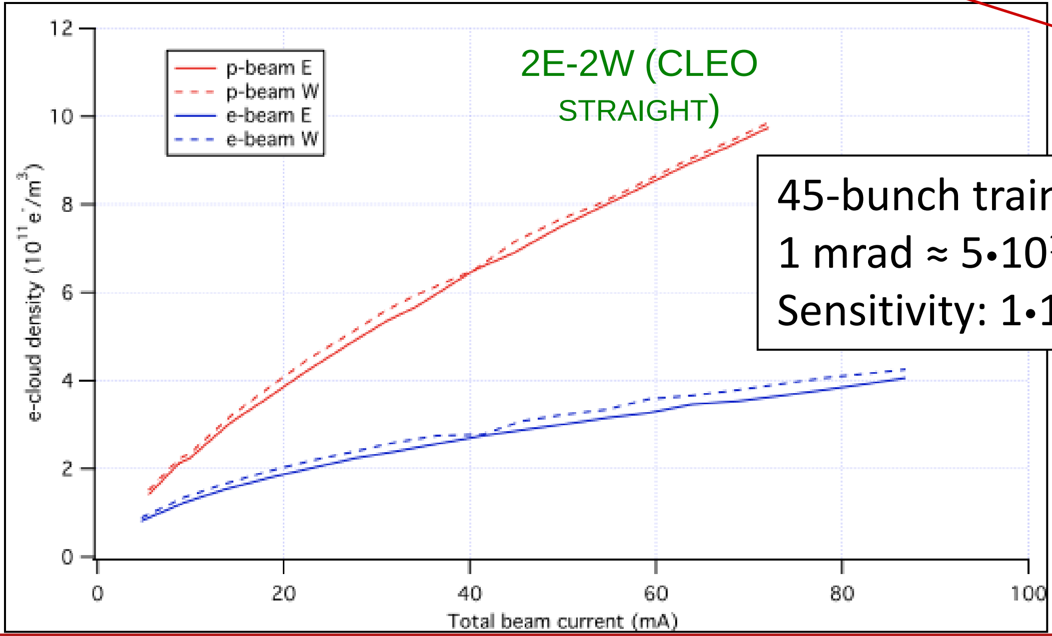
✓ = chamber(s) deployed ✓ = planned

TE Wave & RFA Measurements in L0



45 bunches
14ns spacing
2.2×10^{10}/bunch
After extended scrubbing



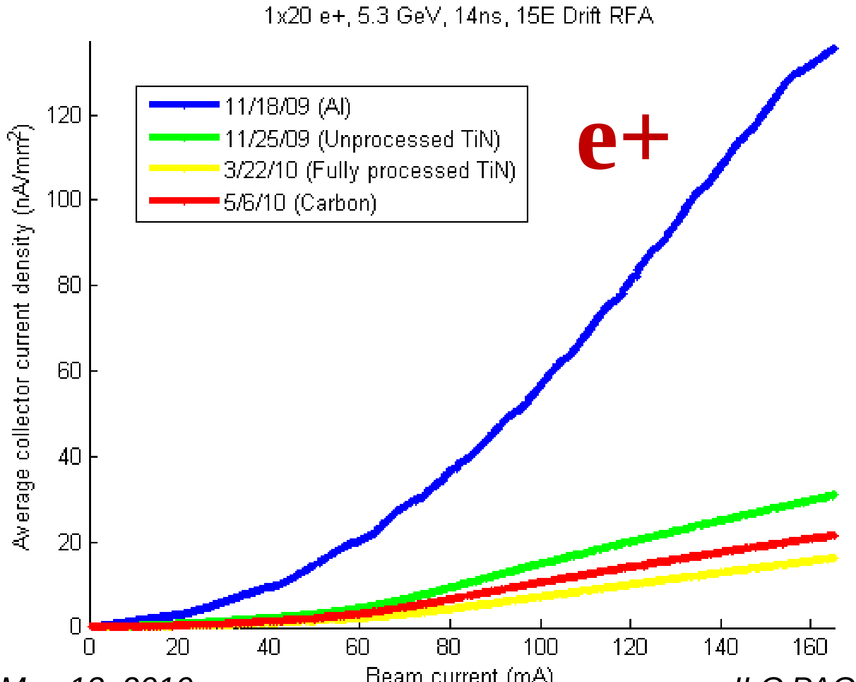


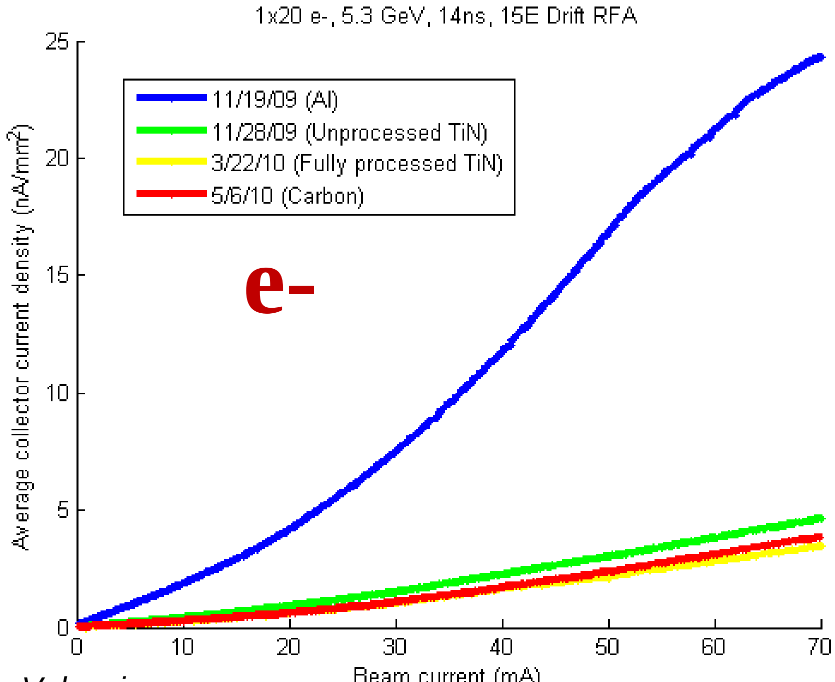
45-bunch train (14 ns)
1 mrad ≈ $5\cdot10^{10}$ e^-/m^3
Sensitivity: $1\cdot10^9$ e^-/m^3 (SNR)

Similar performance observed

15E Drift RFAs

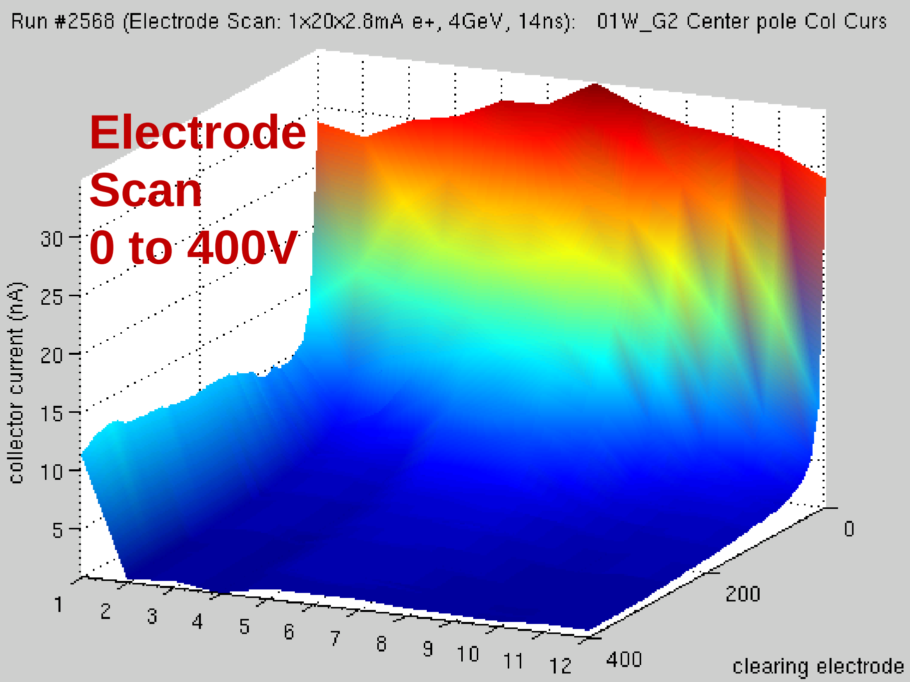
- April 2010 Down
  - Install amorphous C chamber (CERN) in location first occupied by Al chamber and then by TiN chamber
- 1x20, 5.3 GeV, 14ns
  - Compare three different chambers (Al – blue, TiN – green, Carbon – red) that were installed in 15E at different times
  - Both coatings show similar performance, much better than Al - Carbon currently lies in between processed and unprocessed TiN.
  - Will make final comparisons for scrubbed chambers (July 2010 run)

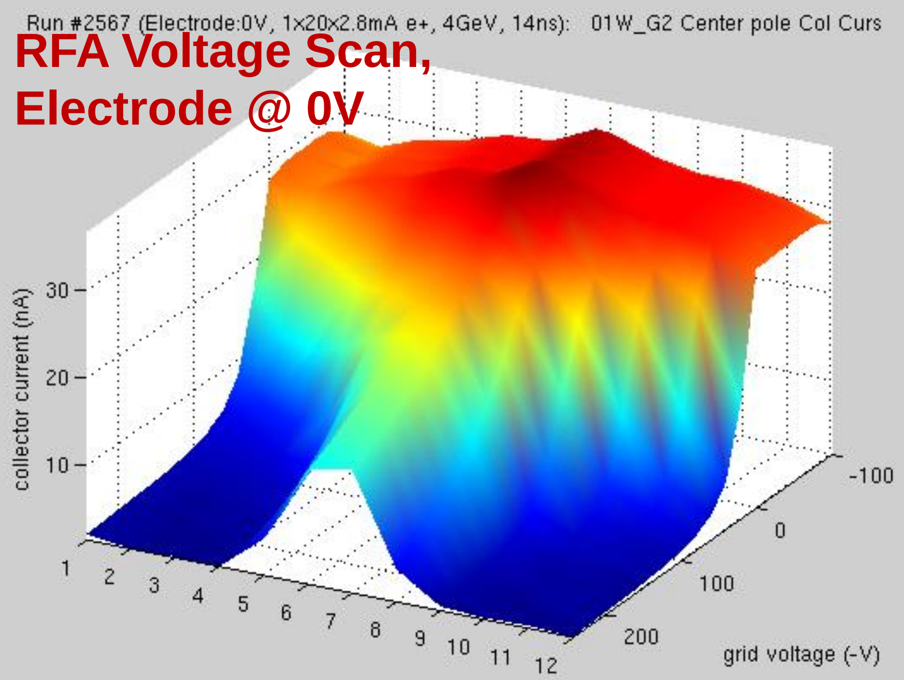


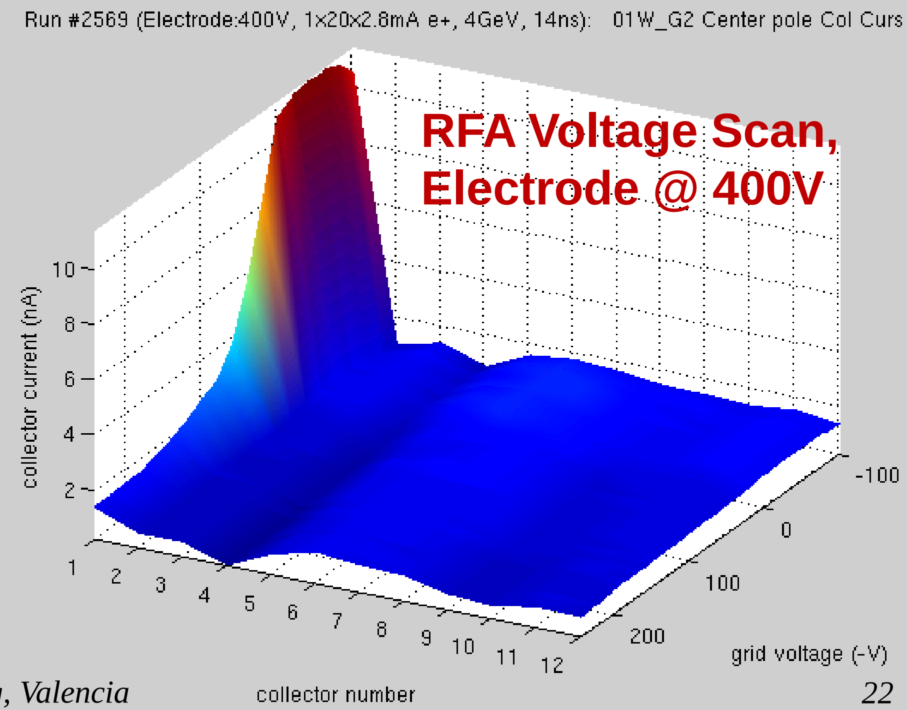


Wiggler Clearing Electrode

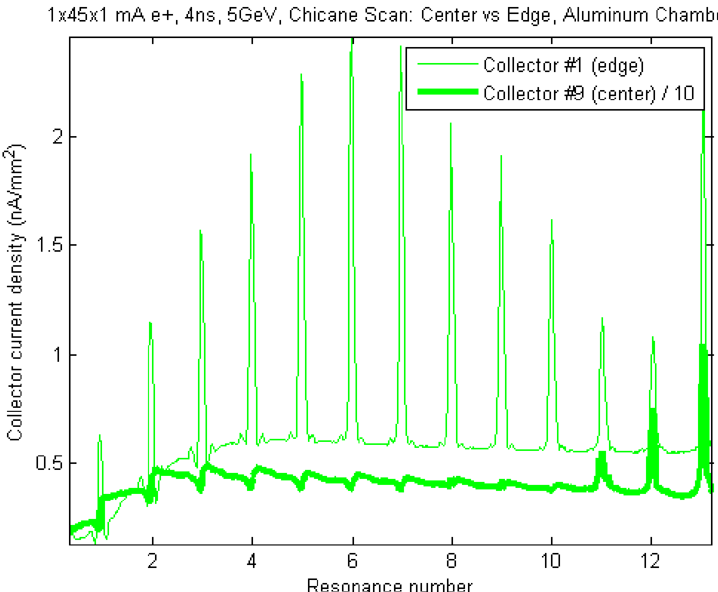
- 1x20x2.8 e+, 14ns, 4 GeV, wigglers ON
- Cloud suppression is very strong, except on collector 1
  - Collector 1 not covered by electrode





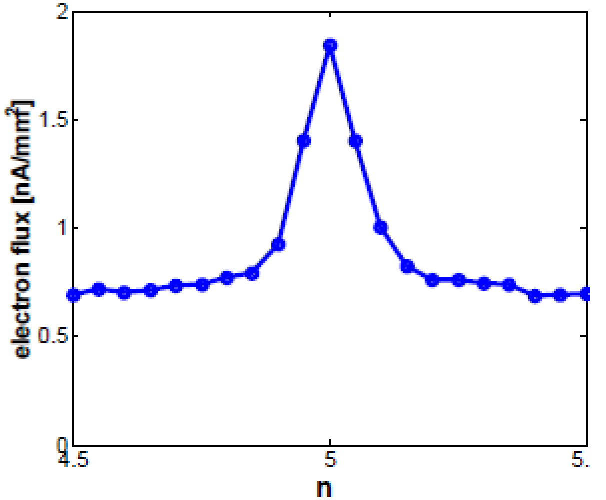


L3 Chicane (SLAC): Measurements & Simulations

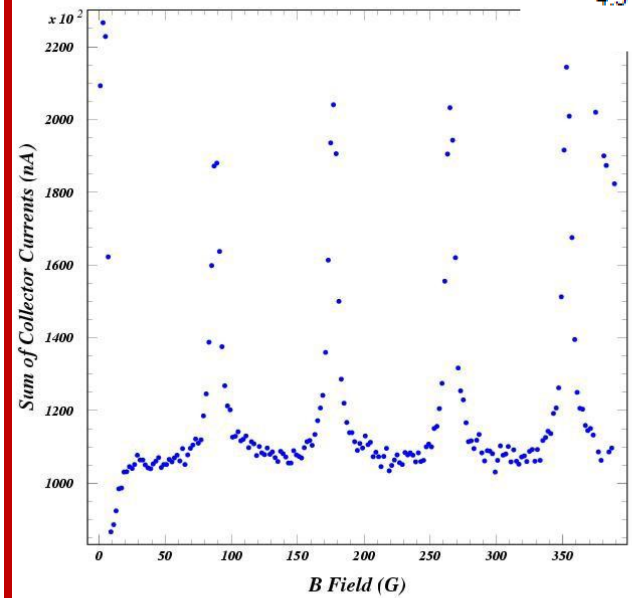


Cyclotron resonances can be reproduced in both ECLOUD and CLOUDLAND

- Plots are of the sum of all collectors for 45 bunches, positrons, 4ns spacing, δ_{max} = 2.0
- Dips are harder to reproduce



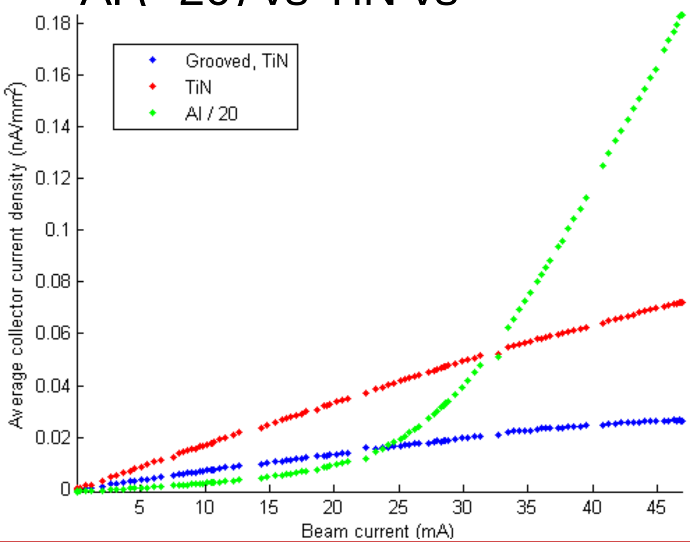
CLOUDLAND (L.Wang)



ECLOUD (J. Crittenden)

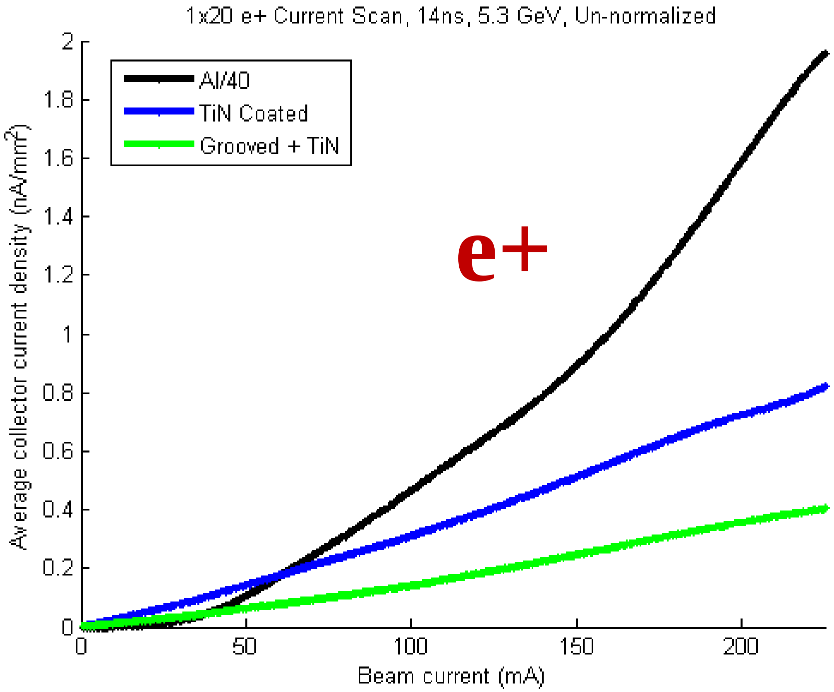
Mitigation Comparisons

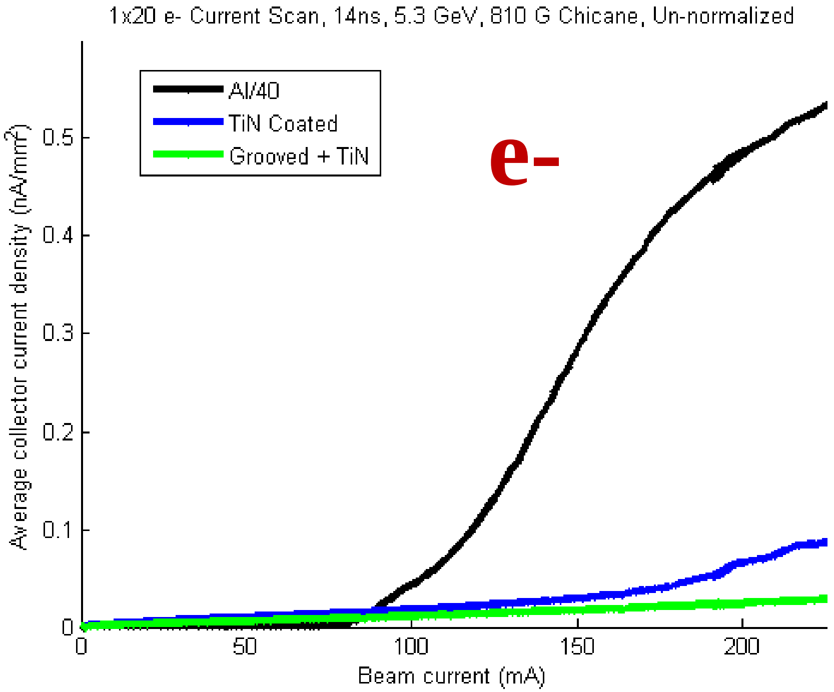
Al (20) vs TiN vs



Mitigation Performance in Dipoles for Positrons & Electrons

- 1x20 e+, 5.3 GeV, 14ns
  - 810 Gauss dipole field
  - Signals summed over all collectors
  - Al signals ÷40



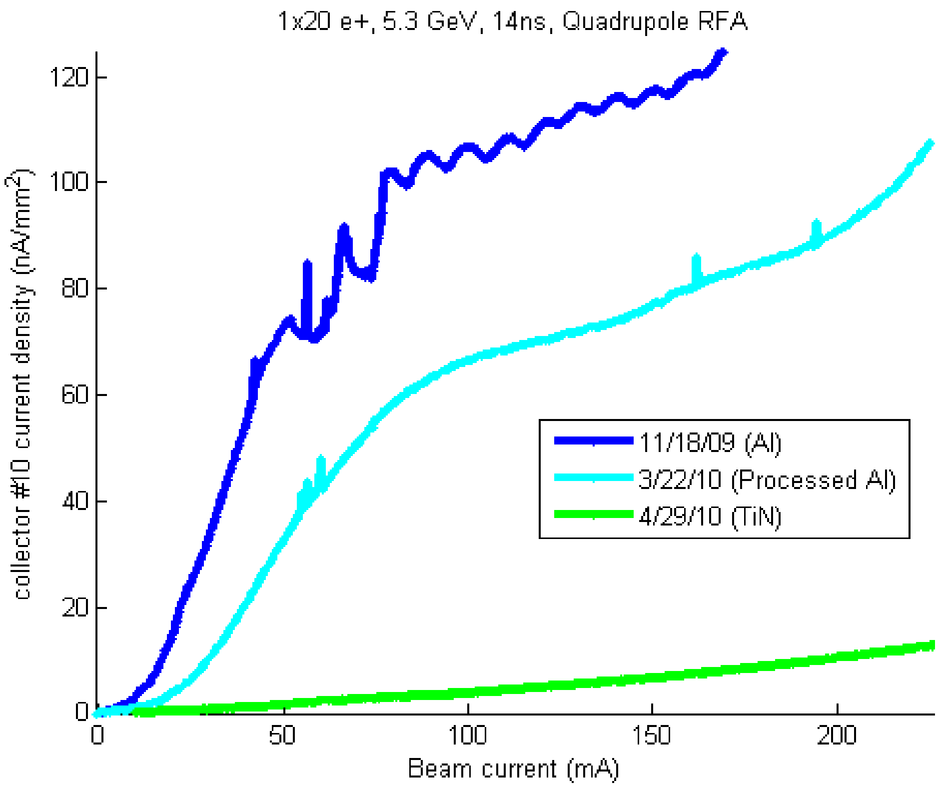


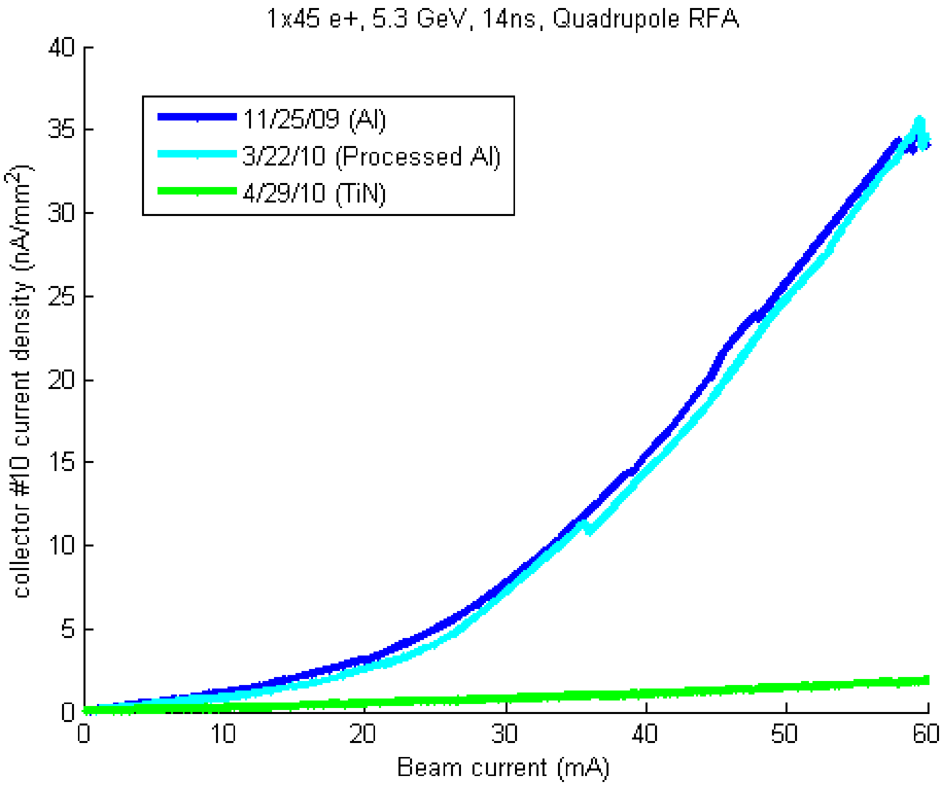
Quadrupole Measurements

- Left: 20 bunch train e+
- Right: 45 bunch train e+

⇨ Clear improvement with TiN

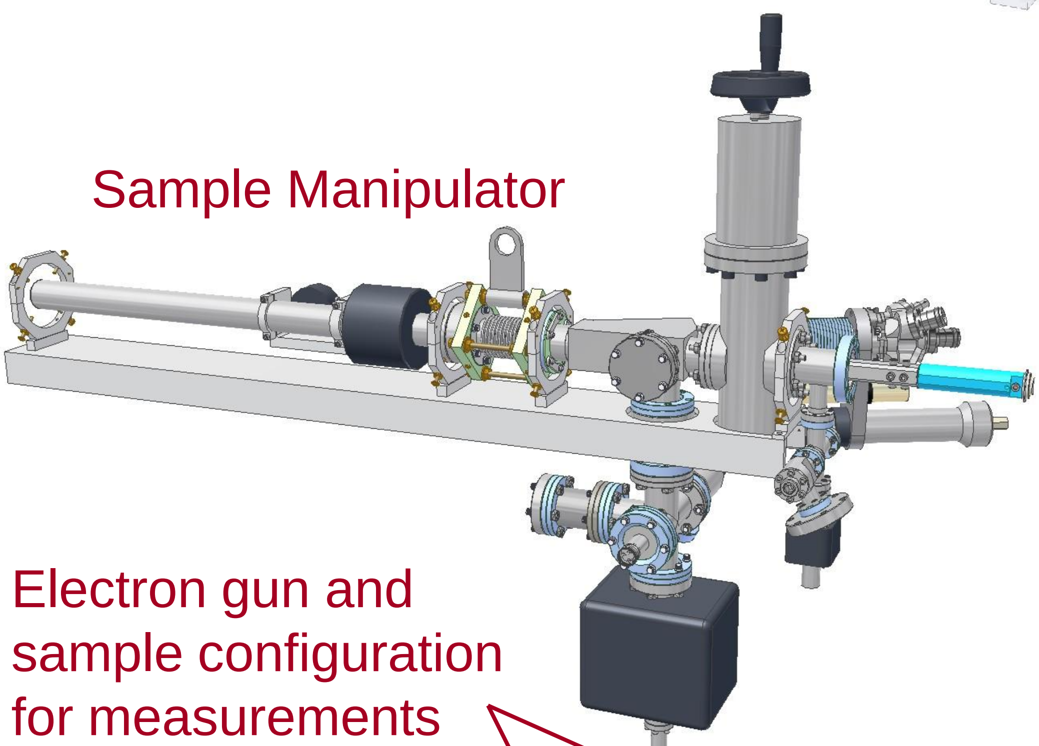
- Currents higher than expected from "single turn" simulations
  - Turn-to-turn cloud buildup
  - Issue also being studied in wigglers



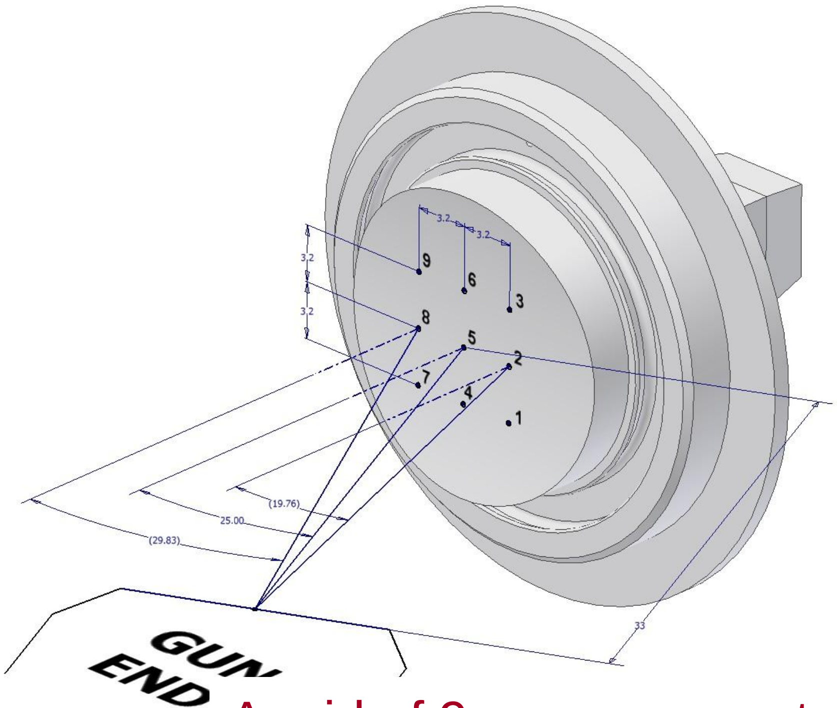


In Situ SEY Measurement System

Sample Manipulator

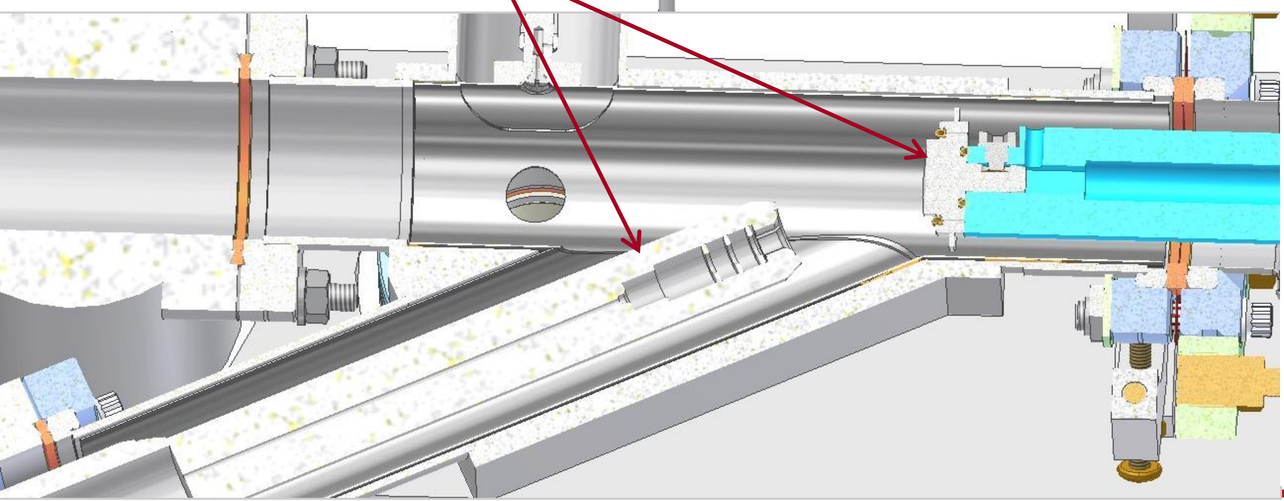


Electron gun and sample configuration for measurements



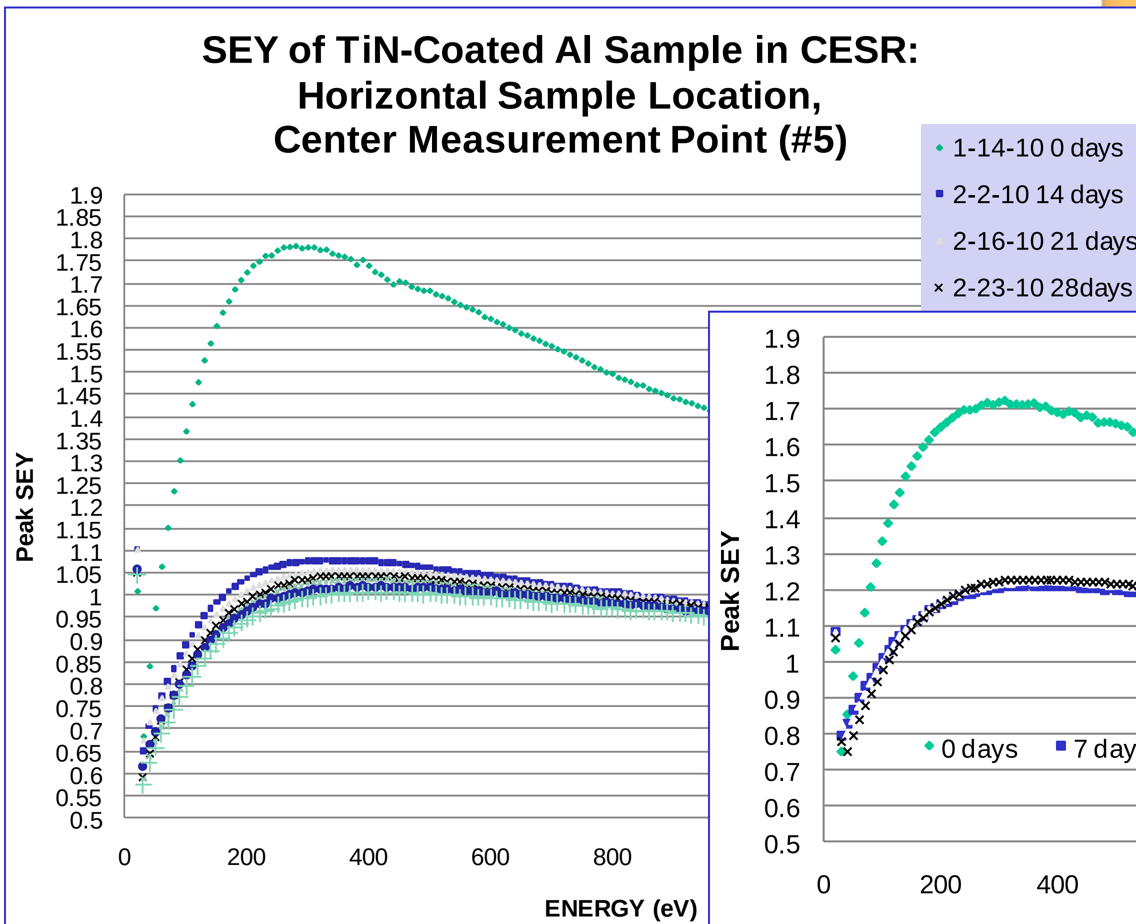
A grid of 9 measurement points is defined on the sample surface and the gun steering electrodes are used to make measurements at each point

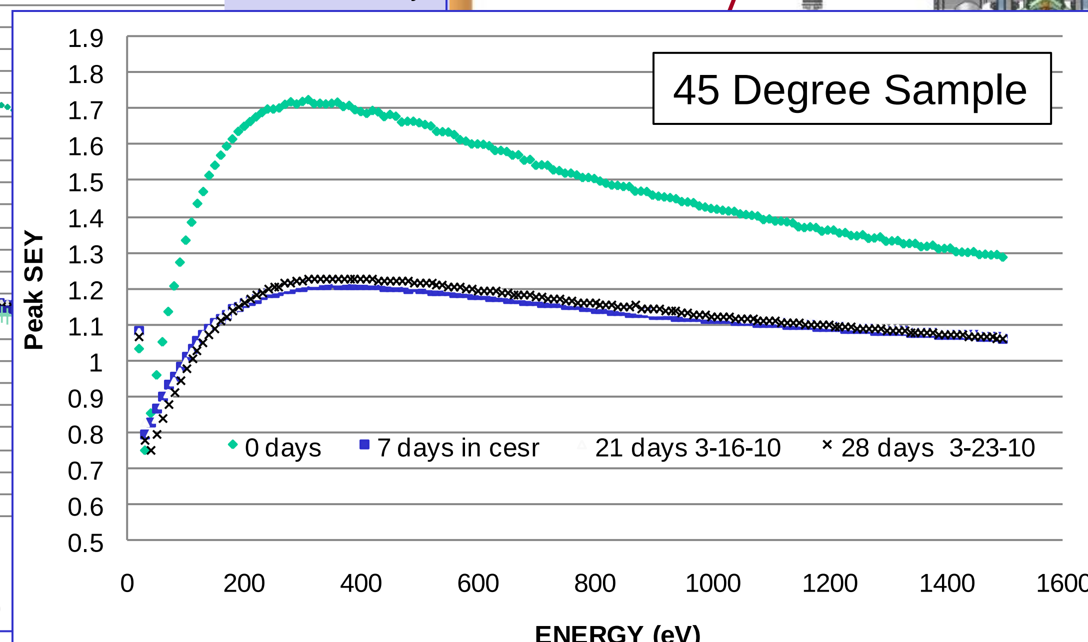
Angles: 20˚, 25˚, 30˚

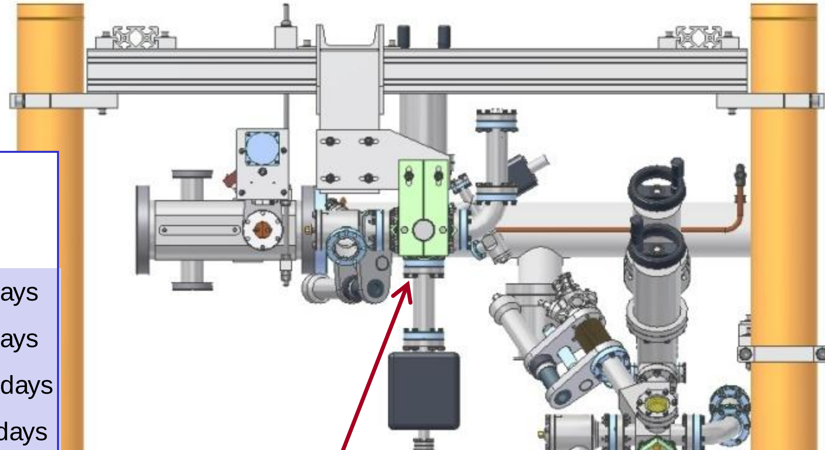


SEY Measurements: TiN

- Rapid initial improvement in SEY followed by a slower processing component



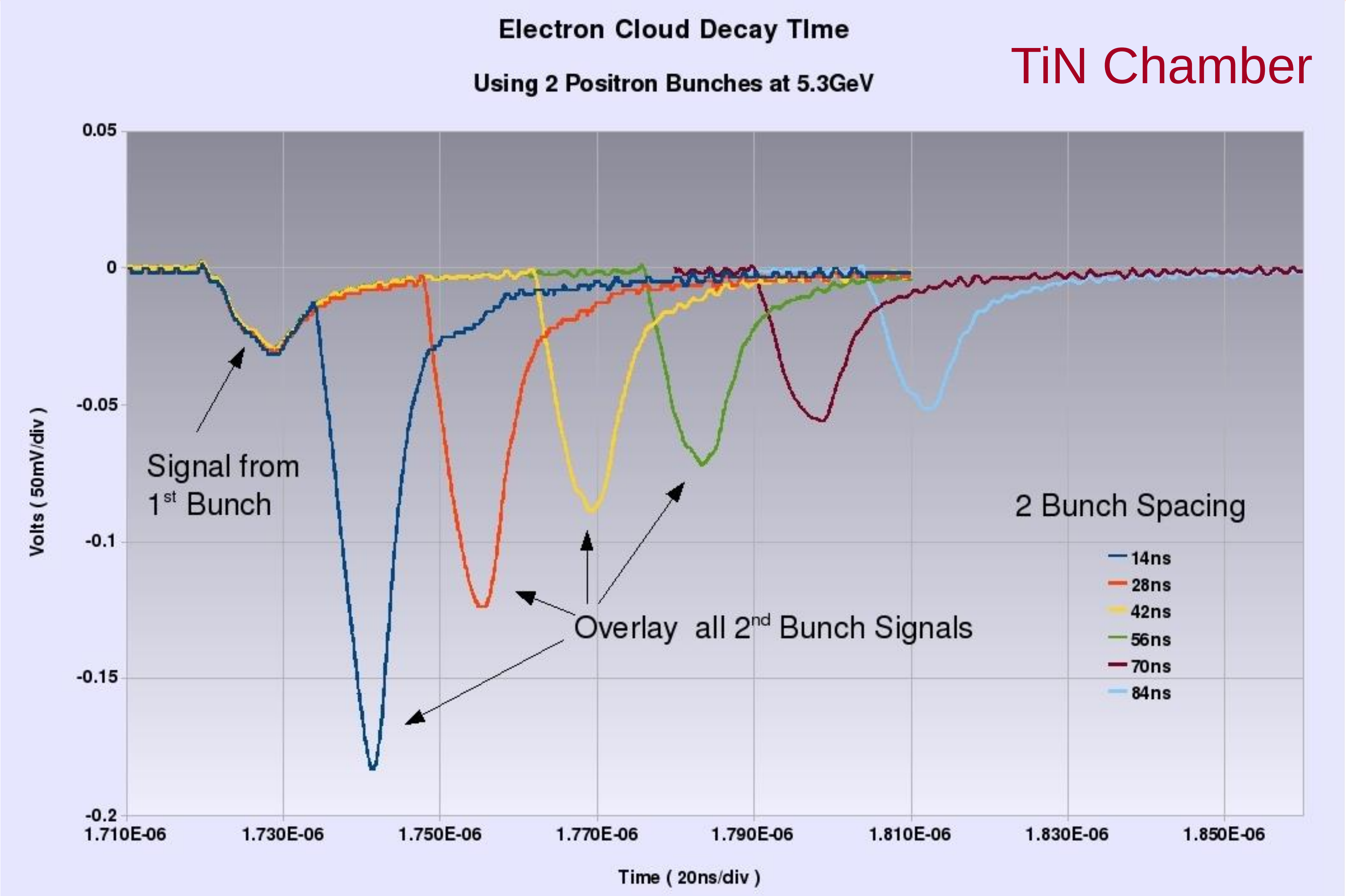




Time Resolved: 4ns Train 1x45 Positrons, 64mA Total

Full Train   Head of Train   Tail of Train

Cloud Evolution: Witness Bunch Studies



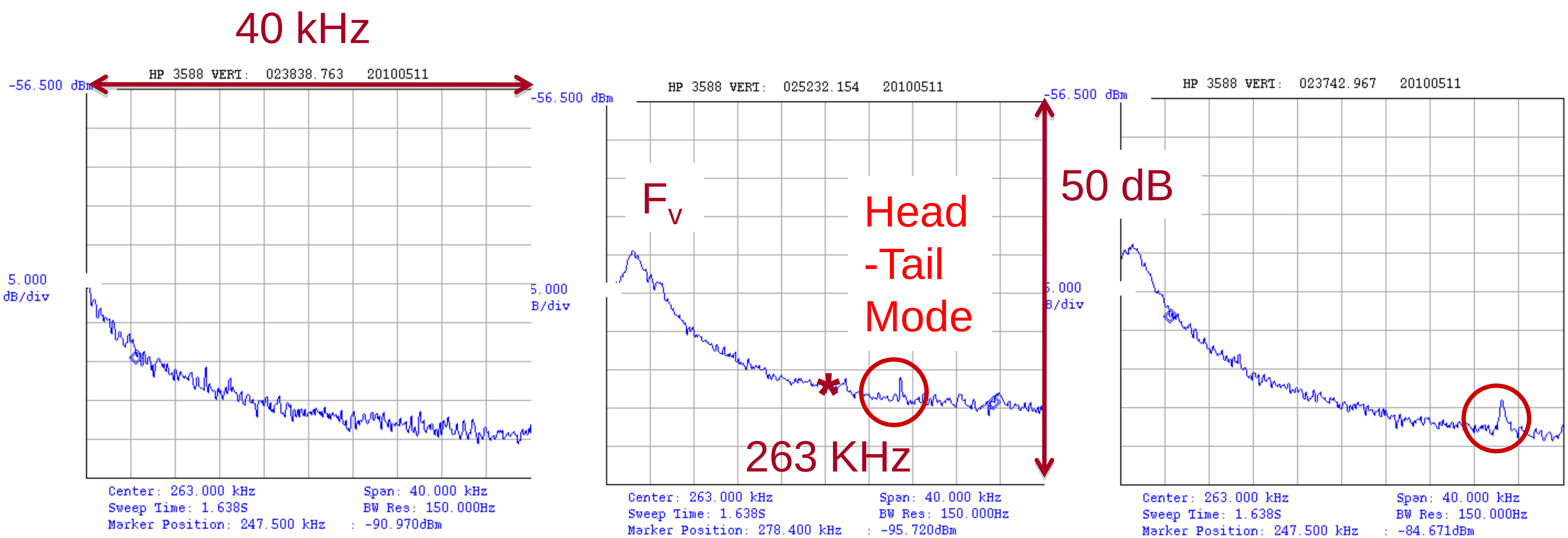
Comparisons with e- and e+ beams are leading to adjustments in our PEY model

Beam Instabilities and Emittance Growth

- A major focus of present run is to explore beam instabilities and emittance growth at ultra low emittance
- Bunch-by-bunch measurements with the xBSM
- Signatures of the onset of the Head-Tail instability
- Much work to do (including more detailed modeling of experiments), but very promising initial results…
- Modeling of instabilities underway
  - KEK-Postech (analytical estimates and simulation)
  - SLAC-Cornell (CMAD)
  - Frascati (multi-bunch instability)

Head-Tail Instability

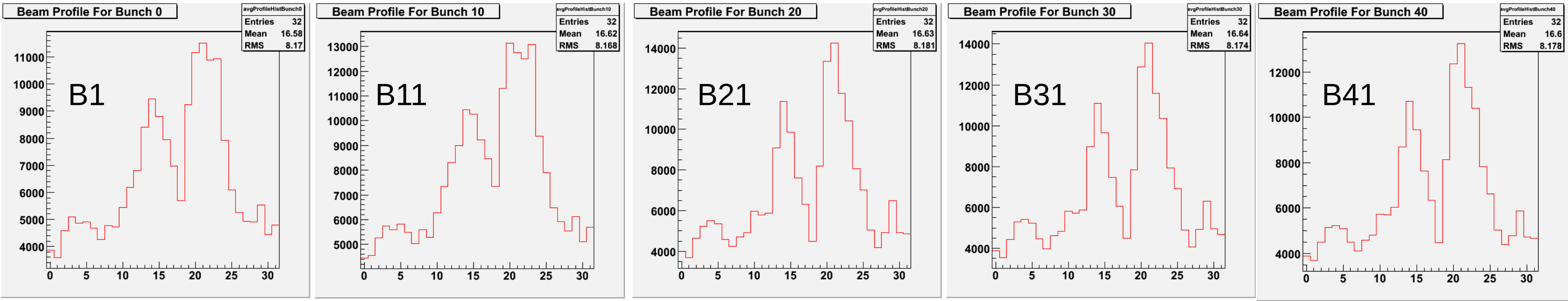
- Positron Train: 45 Bunches @ 1.3mA/bunch
- 2 GeV Low Emittance Lattice
  - F_v & Head-Tail Mode spectra (expected at $F_v + F_s$)
  - Synchrotron Tune ~26 kHz



Bunch #1 Bunch #30 Bunch #40

Emittance Growth

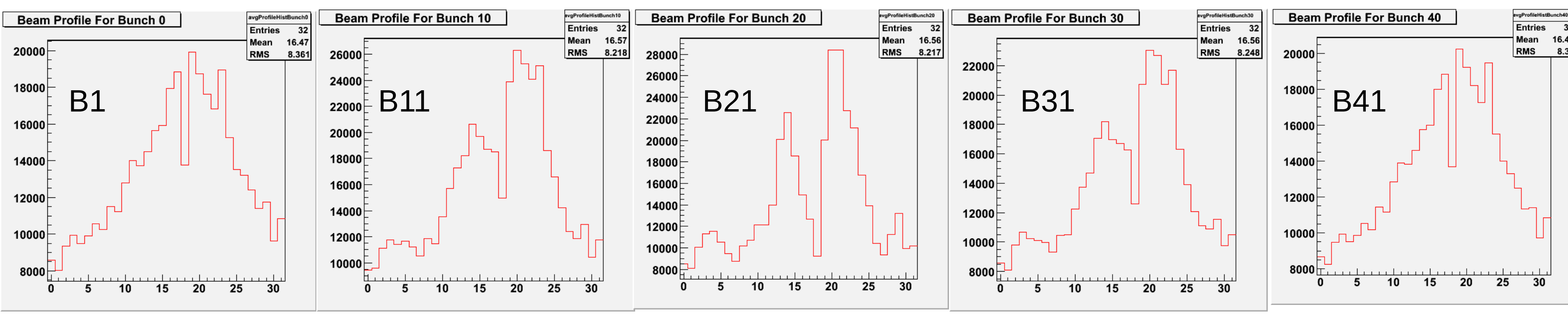
Fast Coded Aperture: 0.5 mA/bunch - 4096 turns averages



Greater depth in structure ⇨ smaller beam size

Head of train likely experiencing blow-up from nearby resonance

Fast Coded Aperture: 1.0 mA/bunch - 4096 turns averages



Turn-by-turn analysis in progress!

Simulation Effort

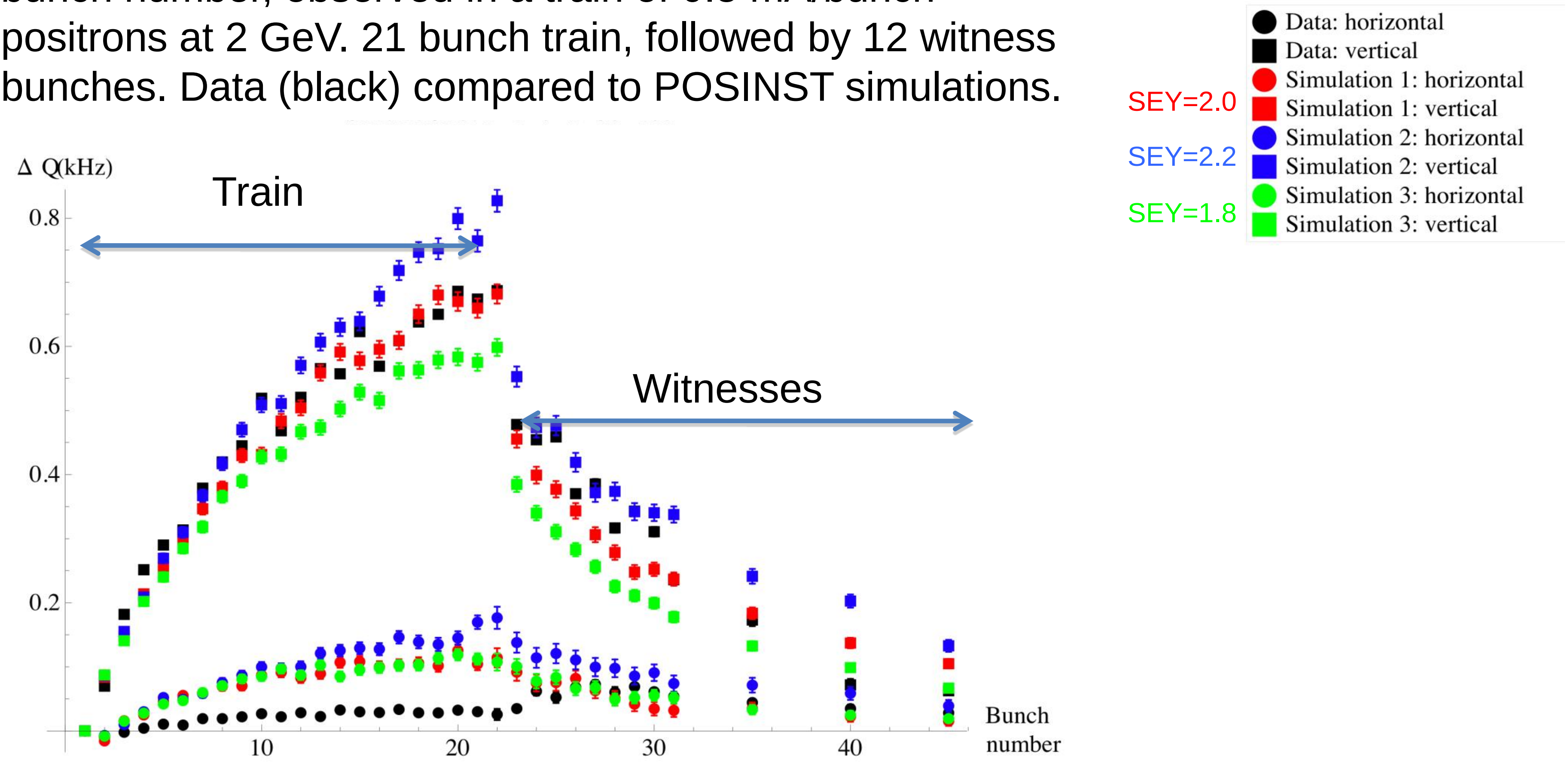
- Multiple Thrusts
  - Simulations and data comparisons for electron cloud currents observed in RFA's
    - Goal is to understand local PEY and SEY performance
    - Particularly in chambers with mitigations
  - Simulations and data comparisons for coherent tune shifts
    - Provides information about the ring-wide impact of the EC
    - Ring-wide model key for instability simulations
  - Improvements to EC simulations:
    - 3D simulations in wigglers
    - Simulations of SR photon production and scattering
      - Full 3D reflection model
      - Understand where photoelectrons are created, particularly in high flux regions (eg, wigglers)
    - Incorporation of experimental results (eg, time-resolved information)
  - Instabilities and incoherent emittance growth.
- Will only be able to touch on a few examples

Coherent Tune Shifts

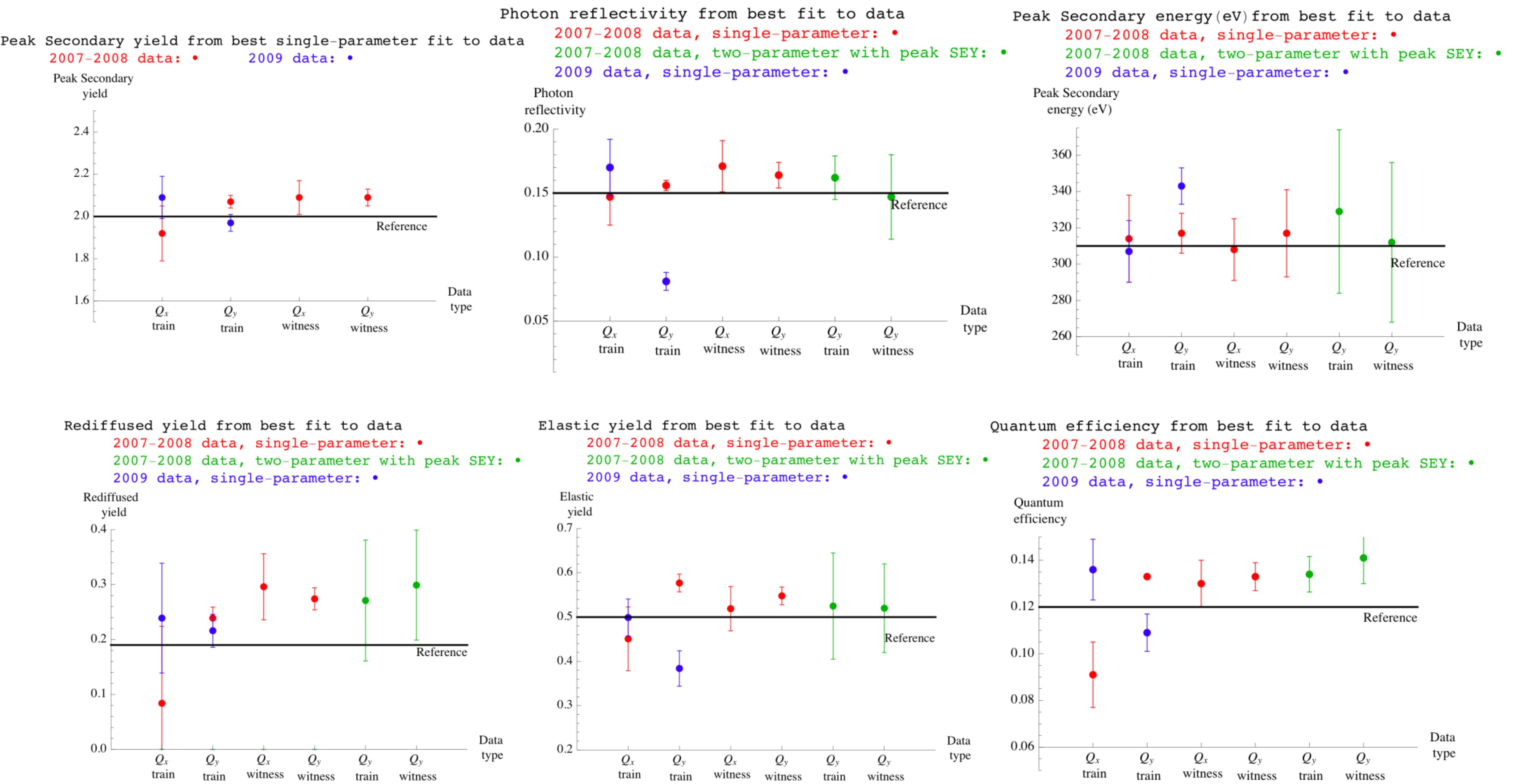
- At CESRTA, we have made measurements of bunch-by-bunch coherent tune shifts along bunch trains, over a wide range of beam energies, emittances, bunch currents, bunch spacings, and train lengths, for both positrons and electrons.
- These measurements have been done by exciting coherent oscillations of whole trains using a single-turn pinger, by observing the tune of self-excited bunches using the Dimtel feedback system diagnostics, and by exciting individual bunches using a fast kicker.
- We have compared the tune measurements with predictions from two electron cloud (EC) simulation programs: POSINST and ECLOUD. We include drifts and dipoles only, so far.
- A range of data were compared with simulations to determine 6 EC model parameters: peak SEY, photon reflectivity, quantum efficiency, rediffused yield, elastic yield, peak secondary energy.

Example: June 2008 positron data, 21 bunch train, 14 ns spacing, 0.8×10^{10}/bunch Peak SEY scan

Plot of coherent tune shifts in kHz (1 kHz ~ 0.0025), vs. bunch number, observed in a train of 0.5 mA/bunch positrons at 2 GeV. 21 bunch train, followed by 12 witness bunches. Data (black) compared to POSINST simulations.

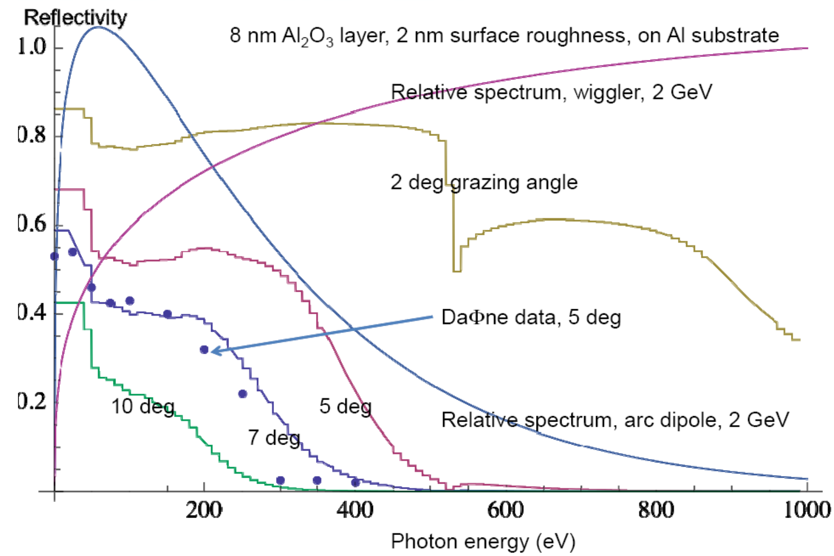


Results of simulation comparisons: 14 ns spacing, coherent train motion



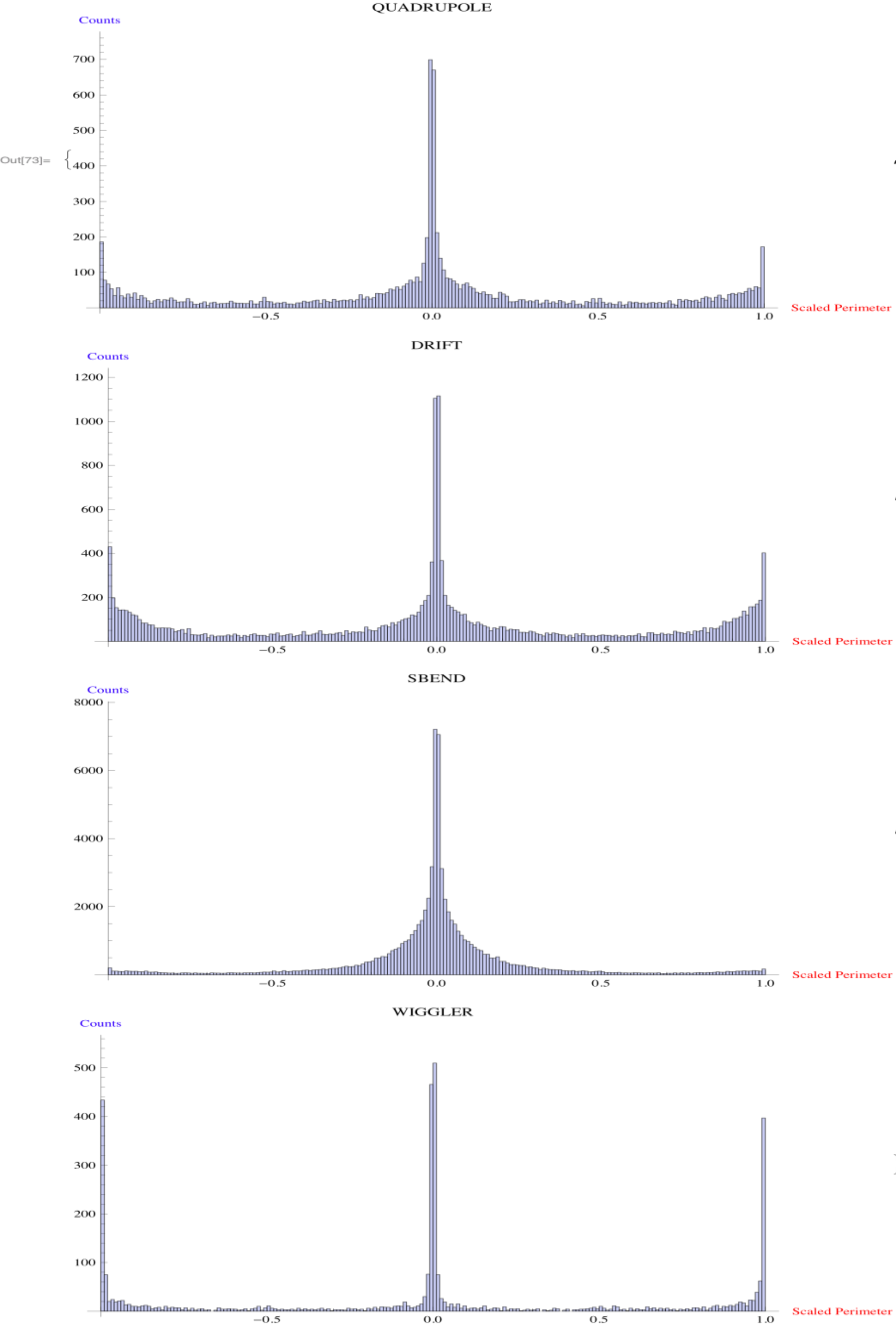
The ability to obtain a set of EC model parameters which works for a wide range of conditions validates the fundamental elements of the cloud model.

Synchrotron Radiation Simulations

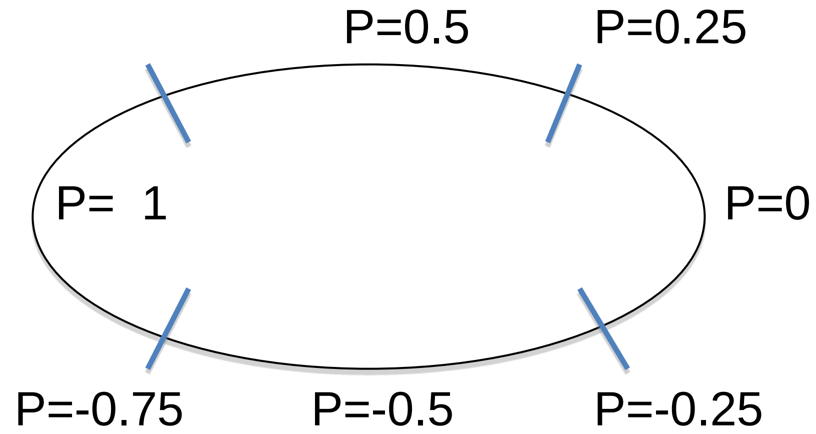


- SYNRAD3D (Sagan, etal): computes the direct and reflected synchrotron radiation distributions for CESRTA.
  - Parameterizes X-ray scattering data from the LBNL online database.
  - Provides azimuthal distributions around the vacuum chamber of photon absorption sites at each ***s*** position around the ring.
- Results needed to understand photon distributions in CESRTA instrumented vacuum chambers
  - Resulting photon distributions show significant differences from typical values obtained from models which ignore reflections – both in azimuthal and in longitudinal distributions
  - For preliminary CESRTA simulations, photon rates in key areas can vary by a factor of several
  - Following slide shows distributions for ring with elliptical chambers
- Work underway to incorporate these results into the RFA and Coherent Tune Shift analyses

Azimuthal location of photon absorption sites



Element-averaged azimuthal distribution of photon absorption sites



x-axis: scaled perimeter, from -1 to 1

Implications for the DR I

- Mitigation performance – a few comments (note that not all measurements have been discussed in this talk)…
  - Grooves are effective in dipole/wiggler fields, but challenging to make when depth is small
  - Amorphous C and TiN show similar levels of EC suppression so both coatings can be considered for DR use
    - Both have worse dP/dI than Al chambers at our present level of processing
    - In regions where TiN-coated chambers are struck by wiggler radiation (high intensity and high Ec), we observe significant concentrations of N in the vacuum system
  - EC suppression with the clearing electrode in the wiggler is very good
    - No heating issues have been observed with the wiggler design in either CESRTA or CHESS operating conditions
  - Further work remains to take RFA measurements in chambers with mitigations and convert these to the effective SEY of the chamber surfaces
    - Agreement between data and simulation continues to improve
    - One area that has not been fully resolved is that we see more EC in our quadrupole test chamber than is expected. Possibly due to trapping and build-up of the cloud over the course of multiple turns. Trapping issues in the wigglers are also being studied (Celata, Wang)
  - In situ SEY measurements raise the question of how the SEY varies around the chamber azimuth
  - First measurements in NEG chamber are underway
    - Also want to test new NEG formulations (lower activation temperature) being proposed for DR use
  - Quadrupole chamber measurements continue (new quad chamber with TiN coating)

Implications for the DR II

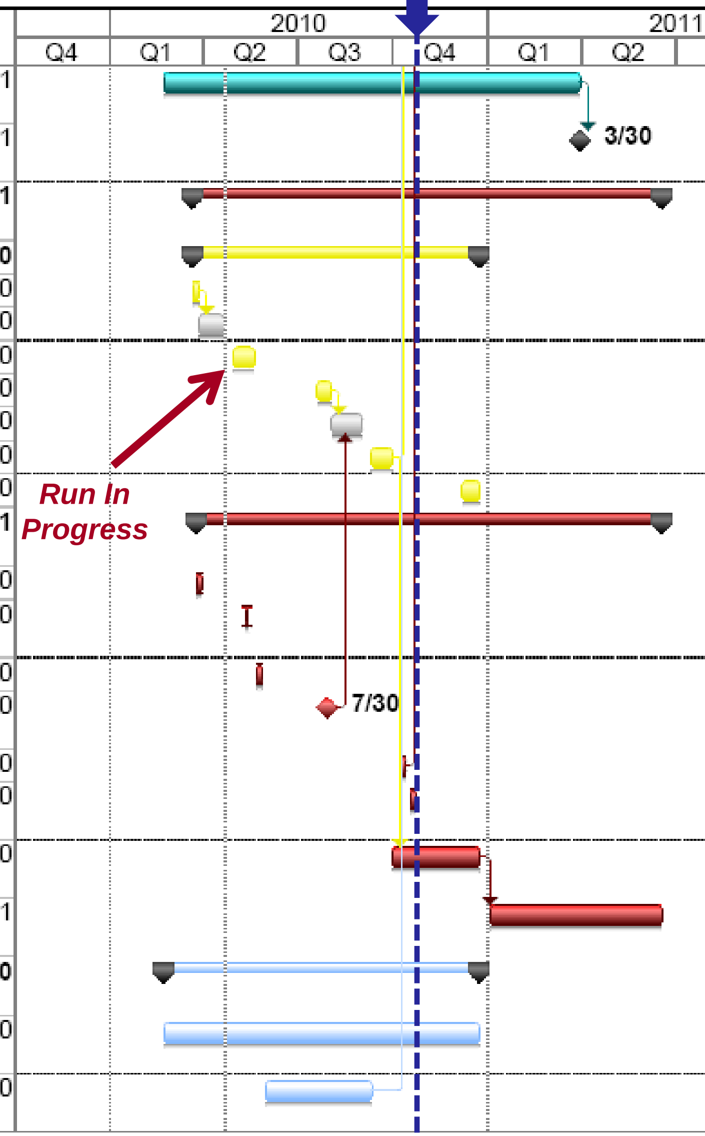
- Time-resolved studies (shielded pickups)
  - Being applied to understand SEY at ~0 energy, $\delta(0)$, which determines EC decay rates
  - Have already shown discrepancies in the PEY spectra being used (e- beam data)
- Photon transport models
  - Detailed 3D simulation shows differences from models typically used
  - Potential implications for modeling assumptions in regions with high photon rates (arc and wiggler regions)
  - *High priority to test this in detail using the CESRTA data and then apply to the ILC DR simulations*
- Low emittance and techniques to measure instabilities and sub-threshold emittance growth
  - Measurement tools are rapidly maturing
  - Coordinated simulation effort with a focus on testing predictions
  - *High priority to carry out systematic studies of the instability thresholds in the low emittance regime*
  - *High priority to design experiments and characterize incoherent emittance growth below the instability threshold. Recent simulation results reinforce this concern.*

Schedule

Baseline EC WG Recommendation

Taken from ILC DR Planning GANTT Chart

ID		Task Name	Duration	Start	Finish
23		Beam Tuning for Fast Kicker Multi-bunch Extraction	282 days	Mon 2/22/10	Wed 3/30/11
24		Begin Standard Fast Kicker Operations	0 days	Wed 3/30/11	Wed 3/30/11
25		**CesrTA Damping Ring R&D**	**319 days**	**Mon 3/22/10**	**Fri 6/17/11**
26		**CesrTA Operations Schedule**	**277 days**	**Mon 3/22/10**	**Thu 12/23/10**
27		Mixed CesrTA/CHESS Machine Devel	6 days	Mon 3/22/10	Sat 3/27/10
28		March Down	24 days	Sun 3/28/10	Tue 4/20/10
29		CesrTA Run 6a	21 days	Fri 4/30/10	Thu 5/20/10
30		CesrTA Run 6b	14 days	Tue 7/20/10	Mon 8/2/10
31		Summer Down	30 days	Tue 8/3/10	Wed 9/1/10
32		CesrTA Run 7a	21 days	Fri 9/10/10	Thu 9/30/10
33		CesrTA Run 7b	17 days	Tue 12/7/10	Thu 12/23/10
34		**CesrTA Phase I Milestones**	**315 days**	**Fri 3/26/10**	**Fri 6/17/11**
35		ILC10 Status Report	5 days	Fri 3/26/10	Tue 3/30/10
36		ILC PAC Status Report	1 day	Thu 5/13/10	Thu 5/13/10
37		IPAC10 Reports	5 days	Sun 5/23/10	Thu 5/27/10
38		Final CesrTA Experimental Hardware Readiness	0 days	Fri 7/30/10	Fri 7/30/10
39		ECLOUD 10 Reports	6 days	Fri 10/8/10	Wed 10/13/10
40		ILC TDP-I Recommendation - Linear Collider Workshop 2010	5 days	Mon 10/18/10	Fri 10/22/10
41		Prepare Summary of CesrTA EC R&D Program (Phase I)	60 days	Fri 10/1/10	Thu 12/23/10
42		Full R&D Technical Report Writing	120 days	Mon 1/3/11	Fri 6/17/11
43		**DAFNE Damping Ring R&D**	**219 days**	**Mon 2/22/10**	**Thu 12/23/10**
44		Fast Kicker Design and Demonstration (5ns Rise-Time)	219 days	Mon 2/22/10	Thu 12/23/10
45		DR Kicker Impedance Evaluation (INFN)	75 days	Mon 5/31/10	Fri 9/10/10



Conclusion

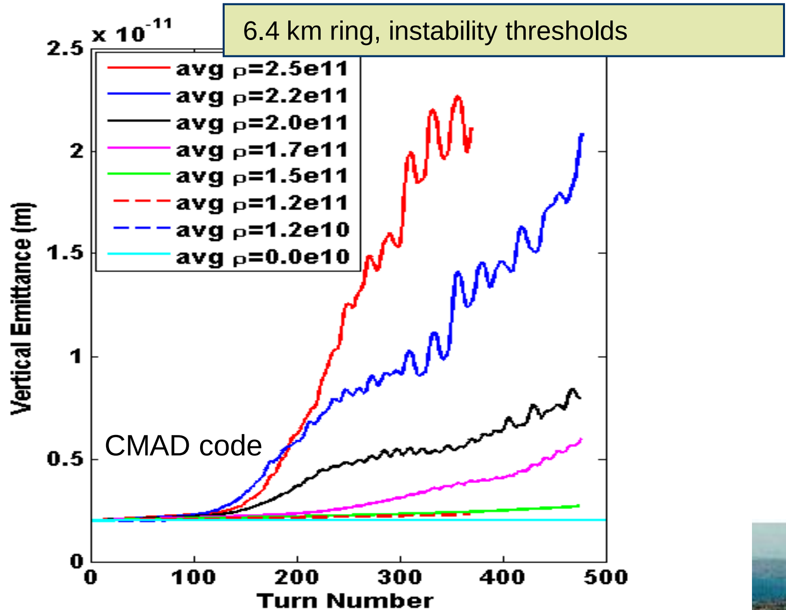
- The CESR reconfiguration for CesrTA is complete
  - Low emittance damping ring layout
  - 4 dedicated experimental regions for EC studies with significant flexibility for collaborator-driven tests
  - Instrumentation and vacuum diagnostics installed (refinements ongoing)
- Recent results include:
  - Machine correction nearing our emittance target ε_y ~ 20pm
  - EC mitigation comparisons
  - Bunch-by-bunch beam size measurements to characterize emittance diluting effects
  - Extensive progress on EC simulations
- ~70 machine development days scheduled in 2010 – May, July, September and December experimental periods. Will focus on:
  - LET effort to reach a target emittance of $\varepsilon_y \leq$ 20pm
  - Continued EC mitigation studies
  - Detailed characterization of instabilities and sources of emittance dilution in the ultra low emittance regime
  - ***Application of our results to the damping rings design effort***
  - An extension to the R&D program has been proposed…
- ILC DR Electron Cloud Working Group
  - Baseline mitigation recommendation targeted for October 2010

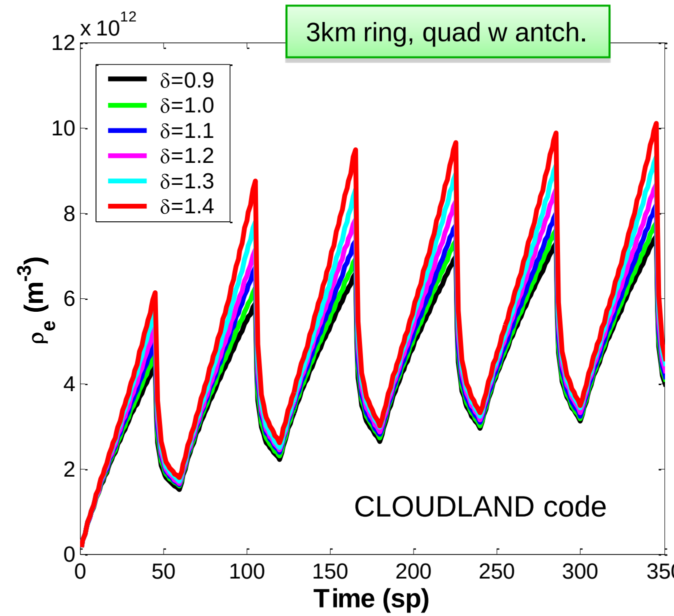
The End

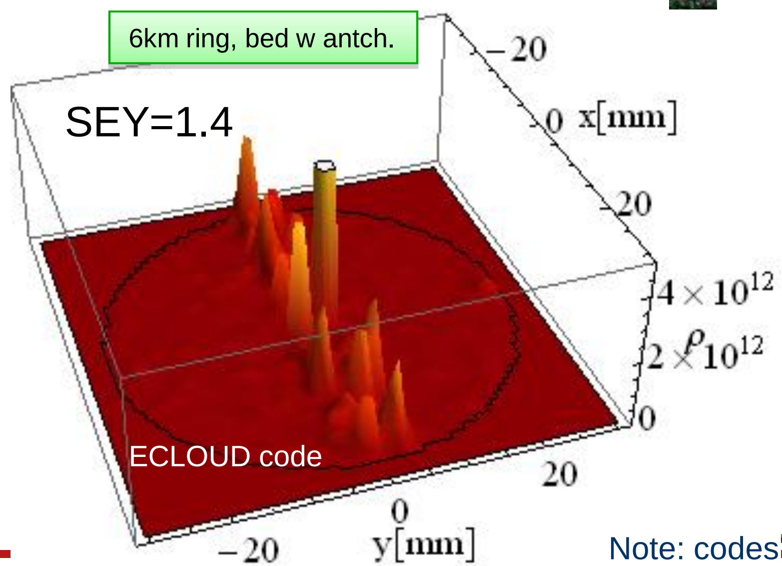
Thank you for your attention!

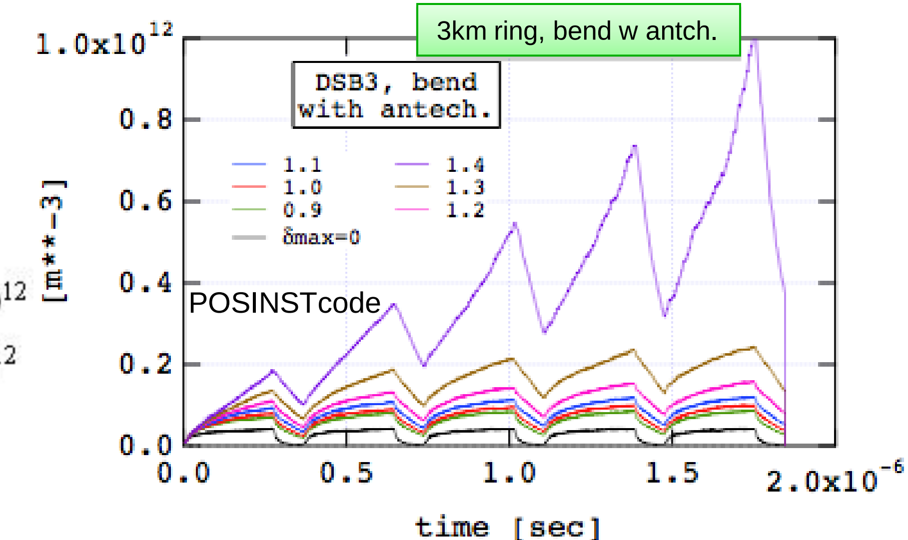
- Extra Slides begin here

ILC Working Group on Electron Cloud 2010: assessing risks for various DR configurations



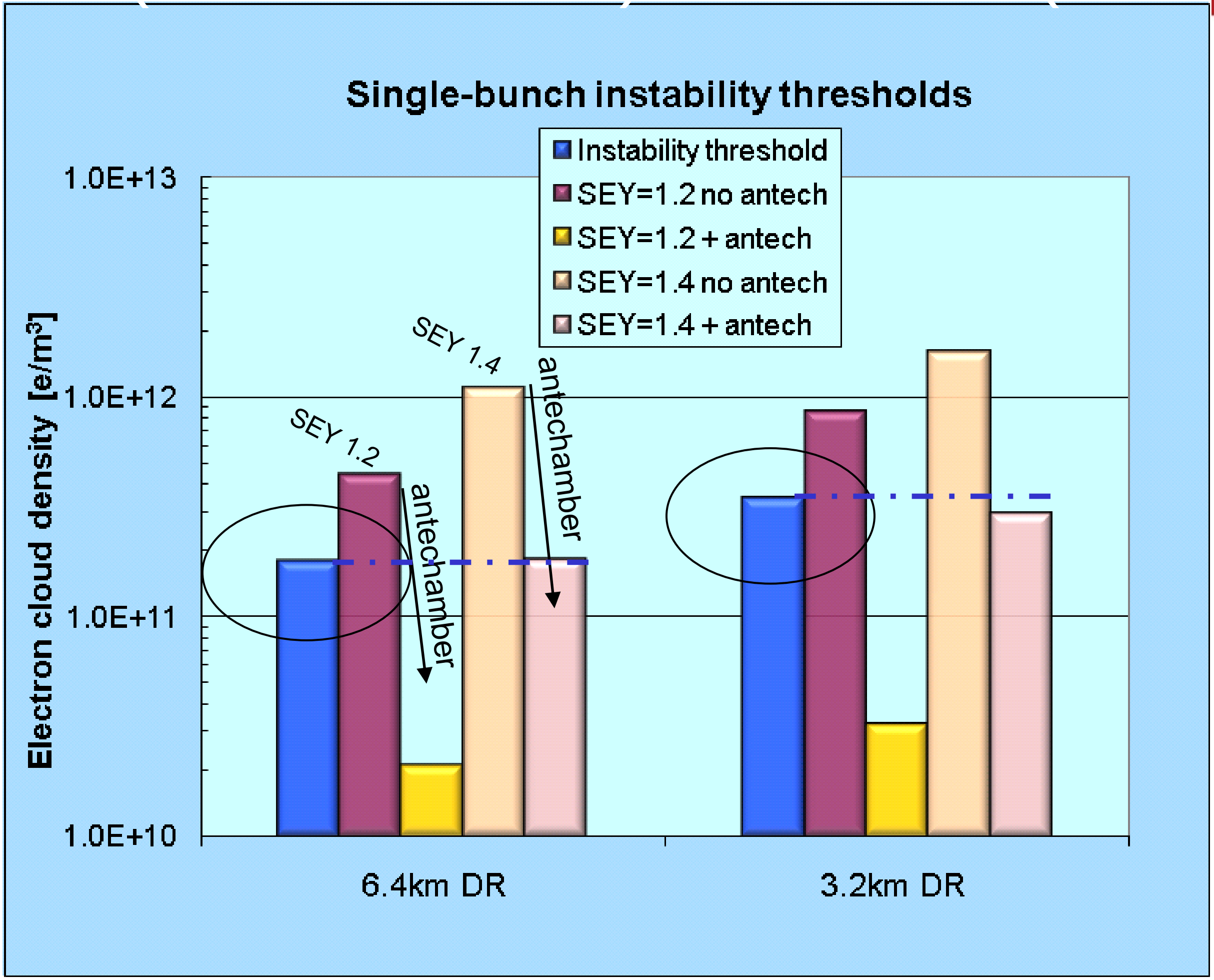






Note: codes used for CesrTA

Compare Thresholds for EC Instabilities for 6.4km (2600 bunches) and 3.2km (1300 bunches)



Simulation Campaign 2010: compiled data of build-up simulations compared with the simulated beam instability thresholds. Overall ring average cloud densities are shown for the 6 km and 3 km rings. The surface Secondary Electron Yield (SEY) determines the cloud build-up and density level.